

## INDEX.

[*Volumes* are indicated by Roman numerals.

*Pages* are indicated by Arabic numerals.]

- Abbildung**: the term, VII, 248; theory, VII, 249—50; (*see also* Transformation of Surfaces).
- Abel, N. H.**: doubly infinite products, I, 120; inverse elliptic functions, I, 136, 156, 173; modular functions, I, 227; a functional equation, IV, 5—6; elliptic integrals, IV, 63, X, 139; quintic equations, V, 55—61, X, 11, XIII, 88; divergent series, VIII, 494; a theorem of, X, 57; theory of equations, XI, 132—5, 455, 513, 518; elliptic functions, XI, 452; series, XI, 627.
- Abelian Functions**: Riemann, VI, 2;  $p=3$ , X, 432—6; early history, XI, 453—4; connected with square roots of sextic and octic functions, XI, 483; the term, XI, 533—4; bitangents of plane quartic, XII, 74; hyperelliptic integrals of first order, XII, 98—9; memoir on theta functions and, XII, 109—216, (introductory, XII, 109; Abel's theorem, XII, 110—20; its proof, XII, 120—31; the major function, XII, 132—48, 149—56; miscellaneous investigations, XII, 157—96; nodal quartic, XII, 196—208; functions  $T, U, V, \Theta$ , XII, 209—16).
- Abelian Integrals**: notes on, I, 366—9; and covariants, II, 189—91; Liouville, IV, 546; Riemann, V, 521; reduction to elliptic integrals, X, 214—22; deficiency of ground-curve, XI, 36; first kind of, XII, 38, 408—11; pure theorem for, XII, 110, 112—6, 119—20, 121, 129—30; affected theorem for, XII, 110, 116—7, 121, 130—1, 164—7.
- Abel's Theorem**: II, 45, 95, XI, 27—8, XII, 30; applied to porisms, IV, 297; Rowe's memoir on, XI, 29—36; note on, XII, 38—41; proof, XII, 120; semi-cubical parabola, XII, 180—6; quadri-quadric curve, XII, 186—9, 292—8; other curves, XII, 189—96.
- Absolute**: and theory of distance, II, 583—92, 604, V, 550; normals of a conic, IV, 74, 77; theory of evolute, V, 476—9; effect on locus in relation to triangle, VI, 53—64; Cayley's theory of, VIII, xxxvi—vii; evolutes and parallel curves, VIII, 31—44; centro-surface of ellipsoid, VIII, 316, 320; in hypergeometry, VIII, 409—13, XIII, 481—504; the term, XIII, 42; minimal surfaces, XIII, 42.
- Abstract Geometry**: memoir on, VI, 456—69, VIII, xxxiii, XI, 441—2.
- Acceleration**: secular (*see* Secular Acceleration).
- Acnodal**: defined, V, 403, 551, XI, 228.
- Acnode**: defined, IV, 181, V, 295, 521, VI, 585, XI, 630.
- Adams, J. C.**: Malfatti's problem, I, 468; moon's mean motion, III, 522, 533—40, 568; lunar theory, VII, 372, VIII, xliii—iv; attraction of ellipsoidal shell, IX, 302; solar eclipses, X, 315.
- Addition**: of elliptic functions, I, 540—9, 589, XI, 73—7, 454, 530, XII, 294—8; of double theta functions, X, 455—62.
- Address**: presidential to British Association, XI, 429—59.
- Adjoint Curve**: IX, 504—7.
- Adjoint Linear Form**: in quartics, II, 319.

**AGGREGATE—APSIDAL.**

- Aggregate:** and relation in abstract geometry, vi, 459.
- Air:** effect on pendulum, iv, 541.
- Airy, Sir G. B.:** a trigonometrical theorem, iv, 80; roots in algebraic equations, iv, 116, ix, 39.
- Algebra:** non-commutative, i, 128—31, 301; notion and boundaries, v, 292—4, 620; Cayley founder of modern, viii, xxx; geometrical illustration of theorems in, ix, 16—7, 21—39; operation connected with covariants, ix, 537—42; expansion theorem, x, 57; system of equations, xi, 39—40; identities, xi, 63—4, 130—1; and time, xi, 443; origin, xi, 445—8; in Greece, xi, 446; and logic, xi, 459, xii, 459; algebraical equations, xi, 506—21; function in, xi, 523—4; Sylvester's work, xiii, 46; Sylvester's principles of universal, xiii, 47; Sylvester on art and, xiii, 48; (*see also* Multiple Algebra).
- Algebraic Curves** (*see* Curves).
- Algebraic Equations** (*see* Equations).
- Algebraic Theorems:** x, 594, 602, 609.
- Algebras, Non-commutative:** i, 128—31, 301.
- Algorithm:** for characteristics of triple theta functions, x, 441—5, 452.
- Allink:** the term, v, 521.
- Allotrious:** the term, ix, 204.
- Alpine Club:** Cayley a member, viii, xi.
- Alternant:** of operators, xiii, 400—1.
- Altitude:** of trees, ix, 429—60.
- America:** Cayley's visit to, viii, xxi.
- American Mathematical Journal:* Sylvester's contributions to, xiii, 47.
- Ampère, A. M.:** inertia, iv, 563, 584; reciprocants, xiii, 366.
- Amphigram:** the term, vii, 268.
- Ampullate:** the term, vi, 101.
- Anallagmatic:** the term, vii, 246.
- Analogues:** of Pascal's theorem, i, 426, 427.
- Analysis:** Bernoulli's numbers in, ix, 259—62; (*see also* Combinatory Analysis).
- Analytical Geometry** (*see* Geometry, analytical).
- Analytical Representation of Curves** (*see* Representation).
- Analytical Theorem:** as to Euler's equation, vii, 261—2.
- Analytical Theory of conics** (*see* Conics).
- Anchor Ring:** and cyclide, ix, 18.
- Angle:** interpreted with reference to two points, vi, 497.
- Anglin, A. H.:** roots of algebraic equations, xii, 33—4.
- Angular Distance** (*see* Distance).
- Anharmonic Ratio:** theory of binary quantics, ii, 565; sextic equation, vii, 314—5, xii, 578—9.
- Anomaly:** expansion of the true, iii, 139—43; and elliptic motion, iv, 521, 523.
- Anti-circle:** the term, viii, 262.
- Anti-conic:** the term, ix, 65.
- Anti-foci:** and foci, vii, 567.
- Anti-point:** the term, vi, 499—500, ix, 65, xiii, 11; problem and solution, vii, 593; orthomorphosis xiii, 184.
- Aoust, L.:** geodesic curvature, xi, 330.
- Aplati** (*see* Penultimate Forms).
- Apoclastic:** the term, xii, 226.
- Applicable Surfaces** (*see* Skew Surfaces, Surfaces).
- Apollonius:** tactions, xiii, 152.
- Apsidal Surfaces:** theory of, xi, 111—3.

- Arbelon**: the term, XII, 57.
- Arbitrary Constants**: in mechanical problems, III, 161—5, 200.
- Arbogast, L.**: method of derivations, II, 257, IV, 265—71, 272—5, 609, XI, 55, 358—60; rule of, VIII, 471, XIII, 267.
- Archimedes**: and statics, XI, 446; theorem for surface of cylinder, XII, 56—7.
- Argand, R.**: imaginaries in plane geometry, XII, 460, 468.
- Arithmetic**: in Greece, XI, 446; Gauss's work, XI, 544.
- Arndt, F.**: mathematical tables, VIII, 51—5, IX, 490—1.
- Aronhold, S. H.**: ternary cubic, II, 325, III, 48, IV, 325—30; on lambdaic of binary quartics, II, 550; hyperdeterminants, II, 598—601; ineunts, IV, 419; intersection of line and conic, v, 501—4; bitangents of quartic curve, VII, 125; construction of a conic, VII, 593; integration formula, x, 12—4; concomitants of ternary cubic, XI, 342; Abelian function, XII, 157; quadric integral, XII, 162—4, 164—7; cubic transformation, XII, 173—9.
- Arrangements**: theory of permutations, I, 423—4; triads of seven and fifteen things, I, 481—4, 589, v, 95—7; of numbers, x, 570; latin squares, XIII, 55—7; (*see also* Combinatory Analysis, Permutations, Substitutions).
- Art**: Cayley's love and practice of, VIII, xxiv; and algebra, XIII, 48.
- Askwith, E. H.**: substitutions, XIII, 117, 133, 141, 145.
- Associative**: the term, XII, 461.
- Associative Algebra**: XII, 303.
- Associative Imaginaries**: XII, 105—6.
- Asteroids**: Newcomb on orbits, IX, 176—7.
- Astronomy**: Cayley's work, VIII, xliii; origin of, XI, 446—7; Gauss's work, XI, 545; transformation of coordinates, XI, 575; Sylvester's work, XIII, 47.
- Asymptotes**: of algebraic curves, I, 46.
- Asymptotic**: the term, XIII, 232.
- Aszygetic**: covariants and invariants, II, 250; the term, VI, 460—1, VII, 336.
- Atomic Theory**: Sylvester's work in, XIII, 47.
- Attraction and Multiple Integrals**: I, 5—12, 13—8, 195—203, 204—6, 285—9, 362—3, 508—10, 586; and theorem of Boole, I, 384—7, 588; and theorem of Jellett, I, 388—91.
- Attraction of Ellipsoids**: I, 432—4, 511—18, VII, 380—3; Gauss's method, III, 25—8, 149—53; Laplace's, III, 53—65, 567; Rodrigues', III, 149—53.
- Attractions**: theory, II, 35—9, III, 154—5, XI, 448; of terminated straight line, VII, 31—3; of ellipsoidal shell on exterior point, IX, 302—11; of lens-shaped body, x, 594.
- Augmented Equation**: XII, 453.
- Ausdehnungslehre**: Grassmann, XII, 480—9.
- Automorphic Transformation**: IV, 416, v, 439; of binary cubic function, XI, 411—6.
- Autopolar Polyhedra**: IV, 185.
- Auxesis**: XI, 79, 81.
- Auxiliars**: the term, VI, 156; application to quintics, VI, 186—7.
- Auxiliary Equations** (*see* Equations).
- Axial Systems**: of polyhedra, v, 529—39.
- Axiom**: twelfth of Euclid, XI, 435, XII, 220.
- Axis**: of inertia, IV, 559—66; cubic surfaces and kinds of, VI, 367; transformation of equation of surface to chief axes, IX, 48—51; radical, XI, 465.
- Axonometry**: IX, 508—18.
- Babbage, C.**: homographic function, II, 494; matrices, XI, 252.
- Babinet, J.**: representation of hemisphere, VIII, 539.

**BACHARACH—BINARY.**

78

- Bacharach, J.:** intersection of curves, I, 583, XII, 500.
- Baehr, G. F. W.:** relative motion, IV, 535, 584.
- Ball, Sir R. S.:** theory of content, II, 606; roots of quartic, V, 610, VII, 551; dynamical equations, IX, 198—200; non-Euclidian geometry, XIII, 481.
- Baltzer, H. R.:** book on determinants, IV, 608.
- Barriers:** the term, X, 320.
- Barycentric Calculus:** Möbius, XII, 472—3.
- Bellavitis, J. L.:** equipollences, XII, 473—4.
- Beltrami, E.:** non-Euclidian plane geometry, XII, 221, 224; orthomorphosis, XIII, 171.
- Bernoulli, James:** analysis and numbers of, IX, 259—62.
- Bertrand, J.:** geodesic lines, III, 38; differential equations, III, 164, 189, 203; integrals and mechanical problems, III, 187, 200—3; *Mécanique Analytique*, III, 189—90, 203; wave surface, IV, 432—4; central forces problem, IV, 519—21, 584; problem of two centres, IV, 532, 584; motion of point, IV, 547, 584; problem of three bodies, IV, 547—52, 584, V, 23; curves of curvature on surfaces, VIII, 98; series, XI, 623, 627.
- Bessel, F. W.:** elliptic motion, IV, 522, 584; precession and nutation, IX, 194—6.
- Bezout, E.:** determinants, I, 63; elimination, IV, 38—9, V, 159, 555—6; equation of differences, IV, 151, 259.
- Bezoutiant:** defined, II, 526.
- Bezoutic Emanant:** defined, II, 525.
- Bezoutic Matrix:** defined, IV, 607.
- Bezoutoid:** defined, II, 526.
- Biaxial:** defined, XIII, 13.
- Bibasic:** defined, XII, 642.
- Bibliography:** of covariants and invariants, II, 598—601; of symmetric functions, II, 602—3.
- Bicentre:** the term, IX, 429—60, X, 599.
- Bicircular Quartic, on the:** X, 223—42; introductory, X, 223—4; formulæ for fourfold generation, X, 224—6; determination as to reality, X, 226; investigation of elementary *arc* formulæ, X, 226—31; inscribed quadrilateral, X, 231—5.
- Bicircular Quartics:** and polyzomal curves, VI, 472; foci of, VI, 521—2, 522—3; analytical theory, VI, 528—30; problem and solution, VII, 575, X, 596—8; geometrical construction, IX, 13—5; generation, XIII, 12; transformation of circle, XIII, 185; (*see also* Quartics).
- Bicircular Quartic Surfaces:** VII, 67, 246; quadric surface inversion, VII, 67.
- Bickmore, C. E.:** Pellian equation, XIII, 442.
- Bicolumn:** the term, IX, 28.
- Bicorn:** the term, VI, 148, 158; equation, VI, 163; form, VI, 164.
- Bicursal Curves:** VIII, 181—7.
- Bicursal Sextic:** and binodal quartic, IX, 581.
- Bien déterminée:** defined, XII, 433.
- Bin:** the abbreviation for tortuous curves, XIII, 253.
- Binary:** the term, IV, 604, VI, 466.
- Binary Cubics:** covariants of, II, 189—91; fifth memoir on quantics, II, 540—5; geometrical representation of covariants of, VII, 332—3; tables of forms, VIII, 51—64; transformation of function, XI, 411—6.
- Binary Forms:** canonic root, V, 103—5.
- Binary Matrices** (*see* Matrices).
- Binary Quadratic Forms:** tables of, V, 141—56, 618.
- Binary Quadrics:** covariants of, II, 189—91; single, II, 527—9; theories of harmonic relation and of involution, II, 529—40; aszygetic covariants of, VII, 337—8.

- Binary Quantics**: canonical form, IV, 43—52, 53; canonical root, V, 103—5; involution, V, 296—301; transformations, VI, 187—90; discriminants of, VII, 303; and covariants, VIII, 566—7, X, 430—1, XI, 272—8; geometrical interpretation, IX, 16—7; factions, IX, 426; derivatives of three, X, 278—86; literal table for, XI, 357—64; finite number of covariants of, XII, 558.
- Binary Quartics**: covariants of, II, 189—91; fifth memoir on quantics, II, 545—56; theorem of four, VII, 100; generating function of, X, 341.
- Binary Quintics**: tables of covariants  $M$  to  $W$  of, II, 282—309; covariants and syzygies of degree 6, VI, 148—53; and sextic, VI, 190; irreducible covariants, VII, 334; tables, VII, 341—6; aszygetic covariants of, VII, 399—400;  $(* \lambda x, y)^6$ , X, 339—400; theorem relating to covariants, X, 430—1; concomitant system for, XI, 272.
- Binary Septic**: minimum N.G.F., X, 408—21.
- Binary Sextic**: and quintic, VI, 190; and squared cubic and cubed quadric, XI, 105; concomitant system for, XI, 272; tables for, XI, 372—6, 377—88.
- Binet, J.**: determinants, I, 63, 64, 581; variation of arbitrary constants, III, 181; relative motion, IV, 535, 584; inertia, IV, 562—3, 584.
- Binodal Quartic**: transformed to bicursal sextic, IX, 581; graphical representation of elliptic functions, XIII, 9—19; (*see also* Quartics).
- Binode**: the term, VI, 330, 335, 361, 362, 583—5.
- Binomial Equation**: theory of numbers, XI, 84—96.
- Binomial Theorem**: factorials and derivations, II, 101, 102, VIII, 463—73.
- Binormal**: the term, XIII, 253.
- Biography**: of Cayley, VIII, ix—xliv.
- Bipartite**: the term, VI, 464.
- Biplanar-node**: the term, VI, 360.
- Biplanes**: the term, VI, 360—1, 362.
- Bipoint-locus**: the term, VI, 198.
- Biquaternions**: Clifford, XI, 458, XIII, 481.
- Bisection**: theory of numbers, XI, 84—96.
- Bitangents**: of a plane curve, IV, 186—206; of quartic curve, IV, 342—8, VII, 123—4, X, 244, XI, 221—3, XII, 74—94; of quartic, and triple theta functions, X, 444, 446; of curves, XI, 473—4, 480; of quintic, XIII, 21.
- Bitetrad**: the term, XIII, 551.
- Bitrope**: the term, VI, 330, 335, 583—5, 591, XI, 228.
- Björling, E. G.**: root limitation, IX, 39; difference table, XI, 144.
- Blissard, J.**: factorials, V, 574.
- Blunt**: the term in seminvariants, XIII, 265, 287, 291, 304—6.
- Bodies, Problem of Three**: III, 183; Hamilton's method, III, 97—103; Jacobi's theorem, III, 519—21, V, 23.
- Body** (*see* Solid Body).
- Bolyai, J.**: hyperbolic geometry, VIII, xxxvii.
- Bondset**: the term, XII, 642.
- Bonnet, Ossian**: problem of two centres, IV, 528, 585; imaginary coordinates, VIII, 569; minimal surfaces, XII, 595; curves of curvature, XII, 601, 629—31; skew surfaces, XIII, 231, 237.
- Book-keeping**: pamphlet by Cayley, VIII, xxiv.
- Boole, G.**: linear transformations, I, 80, 92, 93—4, 428, 584; multiple integrals, I, 198, 384—7, 588; attractions, I, 285, 289; theorem of Jellett, I, 388; transformation of elliptic integral, I, 508—10; discriminants, I, 584; theory of permutants, II, 26; theory of attractions, II, 35; probabilities, II, 103, 594—8, V, 80—4, 85; hyperdeterminants, II, 598—601; transformation, III, 129; formulæ for differentiation, IV, 135; differential equations, IV, 515, V, 301; involution, V, 301; invariants, VIII, xxx; calculus of logic, VIII, 65—6; integration of differential equations by series, VIII, 458;

**BOOTH—CAMBRIDGE.**

80

- prepotentials, IX, 417—23; difference table, XI, 144; matrices, XI, 256; mathematics and logic, XI, 458—9; series, XI, 627.
- Booth, J.:** rotation of solid body, IV, 577, 585.
- Borchardt, C. W.:** symmetric functions, II, 417, 421—3; 16-nodal quartic surface, X, 180; theta functions, X, 464, 499; theorem on trees, XIII, 28.
- Bordered Skew Determinants:** II, 203.
- Boron:** trees of, IX, 429—60.
- Boundaries:** of Algebra, V, 292—4, 620.
- Bouquet, J. C.:** orthogonal surfaces, VIII, 279, 292; periods of elliptic integrals, IX, 618; conformal representation, XI, 80; imaginary variables, XI, 440; elliptic functions, XI, 534; differential equations of first order, XII, 432—41; functions of complex variables, XIII, 190.
- Bour, E.:** differential equations, III, 164, 197—8, 204, IV, 515, 585; problem of three bodies, IV, 550—2, 585; Gaussian theory of surfaces, XI, 331—6.
- Branch:** the term, III, 243, X, 36, XI, 476—7; partial, of a curve, V, 425; of polyzomal curves, VI, 474—6, 481—5; main, of trees, IX, 429—60; theorem on trees, XIII, 26—8.
- Branch-points:** the term, X, 317.
- Brassinne, E.:** differential equations, III, 186—7, 203.
- Bravais, A.:** spherical pendulum, IV, 533, 585; on polyhedra, V, 537, 559.
- Bretschneider, C. A.:** mathematical tables, IX, 486.
- Brianchon, C. J.:** theorem of, I, 328, V, 4; rectangular hyperbola, III, 254; reciprocal polars, XI, 465.
- Briggs, H.:** logarithms, XI, 447.
- Brill, A.:** transformation of plane curves, VI, 593; transformation, and theory of invariants, VIII, 387; sextic curve, IX, 504—7.
- Brinkley, J.:** formulæ of, IV, 262.
- Brioschi, F.:** *Sulla variazione* and *Teorema di Meccanica*, III, 190, 203; *degli integrali di un problema di dinamica*, III, 199—200, 203; peninvariants, IV, 246; text-book on determinants, IV, 608; Schwarzian derivative and polyhedral functions, XI, 149, 151; concomitants of ternary cubic, XI, 342; Jacobian sextic equation, XI, 401; theory of equations, XI, 520; elliptic functions and quintic, XII, 493; transformation of elliptic functions, XII, 505—34, 554—5; wave surfaces, XIII, 238; sextic resolvent equations, XIII, 473, 478, 479.
- Briot, A.:** rotation of solid body, IV, 574, 585; periods of elliptic integral, IX, 618; conformal representation, XI, 80; imaginary variables, XI, 440; elliptic functions, XI, 534; differential equations of first order, XII, 432—41; functions of complex variables, XIII, 190.
- British Association:** report on Catalogue of Philosophic Memoirs, V, 546—8, 620; communications to, V, 549—53; Cayley president 1883, VIII, xxi—xxii; communications on in-and-circumscribed triangle, VIII, 565—6; correspondence of points and lines in space, VIII, 566; covariants of binary quantic, VIII, 566—7; families of surfaces, VIII, 567; Mercator's projection of surface of revolution, VIII, 567; report on mathematical tables, IX, 461—99; Presidential address, XI, 429—59.
- Bronwin, B.:** elliptic functions, I, 118, 119, 127, 132.
- Buchheim, A.:** parallels of, XIII, 481, 489.
- Buée, A. Q.:** multiple algebra, XII, 467, 471.
- Burg, A.:** algebraical theorem, X, 57.
- Burnside, W. S.:** cubic identity, V, 597.
- Cagnoli, A.:** spherical trigonometry, IV, 80.
- Calculus:** of logic, VIII, 65—6; and time, XI, 443—4; of functions, XI, 541—2; of forms; (*see also* Covariants, Invariants, Quantics).
- Calculus of Variations:** Jacobi on, III, 174; problem in, VII, 263.
- Cambridge Mathematical Journal:* foundation, VIII, xii.

- Campaniform**: the term, VI, 101, XI, 479.
- Canonical Elements**: for disturbed motion, III, 77.
- Canonical Forms**: of quantics, II, 523, 542, 548; of binary quantics, IV, 43—52, 53; the term, IV, 606—7, XIII, 46; quintics, VI, 153—4, X, 355—62, XII, 27; cubic surfaces, VI, 361; Sylvester's work, XIII, 46; (*see also* Formulæ).
- Canonisant**: defined, II, 523, IV, 45, 53, 606, 607, V, 103—5.
- Capacity**: of a curve, I, 583; the term, VII, 140; and postulandum, XIII, 115.
- Capitation**: and seminvariants, XII, 248—50.
- Carbon**: trees of, IX, 427—60, 544—5.
- Cardan, J.**: solution of cubic, V, 54, XII, 299.
- Cards**: game of mousetrap, III, 8, X, 256—8; (*see also* Permutations).
- Carey, F. S.**: theory of numbers, XII, 73.
- Carnot, L.**: distances of points, I, 64, 581; on two tetrahedra in perspective, IX, 209—10; geometrical paradox, XII, 305—6.
- Cartesians**: cusp, I, 589; oval of Descartes, II, 336, 365—6, 370; equation of, II, 370—4, 376; defined, VI, 524, XI, 481; with two imaginary axial foci, VII, 241—3; and cubic curve, VII, 556; problem and solution, VII, 582; note on, IX, 45—7; construction, IX, 317, 535—6, X, 261; invention of coordinates, XI, 449; explained, XI, 461; scalene transformation, IX, 532—4; correspondence of confocal, with right lines of hyperboloid, XII, 587—9.
- Casey, J.**: equation of, and tangent circles, VI, 65—71; polyzomal curves, VI, 471—2; bicircular quartics, VI, 540, X, 223—42, XIII, 12; tactions, VI, 543, VII, 115, XIII, 153; circle touching three others, VI, 568—73; cyclides and sphero-quartics, VIII, 262—3; cyclide, IX, 64, 75.
- Cassinian**: note on, IX, 264—5; the word, X, 608; equation of, X, 608.
- Castillon, J. F. S. de**: problem and porism, IV, 435—41.
- Catalan, E.**: attractions, I, 288; integral calculus, I, 313; series, III, 127, XI, 627; curve parallel to ellipse, IV, 152; minimal surfaces, XII, 594—5.
- Catalecticant**: the term, II, 523, IV, 606, 607.
- Catalogue of Scientific Papers**: issued by Royal Society, V, 546—8, 620.
- Catenary**: and epitrochoid, XIII, 87.
- Cauchy, A. L.**: determinants, I, 63, 64, 66; inverse elliptic functions, I, 148, 157, 174; integral calculus, I, 309, 314; permutations, I, 423; partitions, II, 248, V, 48, VII, 577; differential equations, III, 166, 169; theory of logarithms, III, 208—13, 225; polyhedra, IV, 86—7; singularity of function, IV, 105; curve parallel to ellipse, IV, 152; equations of motion, IV, 514, 585; elliptic motion, IV, 524, 585; inertia, IV, 560, 564, 565, 585; geodesic lines on ellipsoid, VII, 498; geometrical representation of root-limitation, IX, 21—39; series, IX, 61, XI, 627; mathematical tables, IX, 475; theory of equations, X, 6, XI, 504; correspondence, X, 290; monogenous function, XI, 537; theory of numbers, XI, 601; roots of algebraic equations, XIII, 35.
- Caustics**: by reflection at circles, I, 273—5, II, 118—22, 129; memoirs on, II, 336—80, V, 454—65; tracing of, II, 351—2, 362—3, 368—9, 374.
- Cavalieri, B.**: quadrature of curves, XI, 641.
- Cayley, Arthur**: portraits of, frontispiece to vols. VI, VII, XI; manuscript of, frontispiece to vol. VIII; biography of, VIII, ix—xliv; mathematical tables, IX, 479, 487, 491.
- Cayleyan**: the word, I, 586, II, 381.
- Central Forces Problem**: IV, 517—21.
- Centres**: problem of two, III, 104—10, IV, 527, 528—9, 589; cubic, and cones, IV, 173—8, 179—81; of curves defined, VI, 522; four points and conic of, VII, 582; of trees, IX, 429—60; the term, X, 599; of three circles, XI, 552.
- Centro-curve**: kinds of, VIII, 320.
- Centro-surface**: of ellipsoid, VIII, 8; the term, VIII, 316; Rudio's inverse, XII, 457—8.

**CESSER—CLAIRAUT.**

82

**Cesser**: points of, IV, 130.**Challis, J.**: integration of differential equations, VII, 36.**Chance** (*see* Probability).**Characteristic Function**: of Hamilton, III, 217; for systems of rays, XII, 571.**Characteristics**: logic of, III, 51—2; of Chasles, V, 552; theory, VI, 594, XIII, 468—72; of triple theta functions, X, 441—5.**Chartography**: surface representation on plane, VIII, 538—9; colouring of maps, XI, 7—8; map projections, XI, 448.**Chasles, M.**: intersections of curves, I, 25—7; Pascal's theorem, I, 45; theorem on correspondence, I, 212; a theorem of, demonstrated, I, 355; analogue of Pascal's theorem, I, 427; transformation of curves, I, 478—80; homography, II, 538; cubic curves, IV, 122, 495; inertia, IV, 561, 586; kinematics of solid body, IV, 580, 586; curves on a quadric, V, 11; on a cubic, V, 19; conics touching curves, V, 31—2, 552; scrolls, V, 169, 201, VI, 328; quartic scrolls, V, 201; cubic curves and cones, V, 401; equilibrium of four forces, V, 540—1; correspondence of points in plane curve, V, 542; contact of conics, V, 552; characteristics, V, 552; on united points, VI, 9; curves which satisfy given conditions, VI, 191, 192, 200—26; principle of correspondence, VI, 264, XI, 482, 485—8; foci of conics, VII, 1; six coordinates of a line, VII, 93; attraction of ellipsoids, VII, 380—3; locus *in plano*, VII, 605; cones satisfying six conditions, VIII, 99; penultimate forms of curves, VIII, 258; theory of duality, XI, 467.**Chemistry**: Cayley's interest in, VIII, x; application of trees to, IX, 202—4, 427—60, 544—5.**Chessboard**: topology of, X, 609—10.**Chord**: angle between normal and bisector, X, 576; of two circles, XI, 552—6.**Christie, J. T.**: Cayley's law work, VIII, xiii—iv.**Christoffel, E. B.**: orthomorphosis, XIII, 180.**Chrystal, G.**: uniform convergence, XIII, 343—4.**Chuck**: for quartic curves, VIII, 151—5; for curve-tracing, VIII, 179—80; bicyclic, VIII, 209—11.**Circle**: Salmon's equation for orthotomic, III, 48—50; and points, V, 560; and ellipse, V, 561; line and parabola, V, 607; envelope of, V, 610; equation of, VI, 501, XI, 558—61; potential of, IX, 290—301; quadrilateral inscribable in, X, 578; orthomorphosis, XII, 328—36, XIII, 20, 182, 202—5; Wallis's  $\pi$  investigation, XIII, 22—5; transformation into bicircular quartic, XIII, 185; and circumference, the terms, XIII, 194; the nine point, XIII, 517—9, 520—1, 548—51; of curvature of an ellipse, XIII, 537.**Circles**: powers of, I, 581; systems of, III, 111—4, X, 566; in-and-circumscribed polygon, IV, 303—8; a pair touching three given, VI, 65—71; involution of four, VI, 505—8; relation between two, VIII, 12—3; equal, VIII, 31; minimum enclosing three points, X, 576; system of 15 connected with icosahedron, XI, 208—12; radical axis, XI, 465; radical centre of three, XI, 552; Mascheroni's geometry of the compass, XII, 314—7; system of three which cut each other at given angles, XII, 559—61, 564—70; the two relations connecting the distances of four points on a circle, XII, 576—7; roots of algebraic equation, XIII, 37; problem of tactions, XIII, 150—69; tetrads of, XIII, 425—9; (*see also* Casey, Orthomorphosis).**Circuit**: the word, XI, 480.**Circular**: the word, XI, 481.**Circular Cubic**: and polyzomal curves, VI, 522—8.**Circular Points**: at infinity, VIII, 32.**Circular Relation of Möbius**: III, 118—9, IX, 612—7.**Circumference**: and circle, the terms, XIII, 194.**Cissoid**: the term, XI, 461.**Clairaut, A. C.**: lunar theory, IV, 518, 586; demonstration of his theorem, X, 17—8; curves of double curvature, XI, 489.



- Classes** : of curves, II, 569—83, V, 518, 521, VI, 11, XI, 629.
- Classification** : of curves, V, 613—7; cubics and quartics, VI, 525; quartic surfaces, VII, 244; nodal quartic surfaces, VII, 264—7; mathematical tables, IX, 424—5; cubic curves, XI, 478—80; quartic curves, XI, 480.
- Clausen, T.** : Castillon's problem, IV, 435—41.
- Clebsch, R. F. A.** : Steiner's extension of Malfatti's problem, II, 593; Pfaffian equations, IV, 515; singularities of curves, V, 476—7; developable surfaces, V, 518; Abelian integrals, V, 521; transformation of plane curves, VI, 1—8, 593; Casey's equation, VI, 67; binary quintic and sextic, VI, 190; principle of correspondence, VI, 264; reciprocal surfaces, VI, 356; cubic curve in pencil of six lines, VI, 593—4; centro-surface of ellipsoid, VII, 130, VIII, 316; quartic and quintic surfaces, VII, 245—51, 313; bicursal curves, VIII, 182; transformation of unicursal surfaces, VIII, 389; deficiency of surfaces, VIII, 394; covariants, VIII, 404; expression for elliptic integral of second kind, X, 27; concomitants of ternary cubic, XI, 343; tables for binary sextic, XI, 372; Abelian functions, XII, 102, 109; symbolic notation for quantics, XII, 347; seminvariants, XIII, 362; Pfaff-invariants, XIII, 405—14.
- Clifford, W. K.** : powers of circles and spheres, I, 581; circle and ellipse, V, 561; conic, V, 562; triangles and polygons, V, 589; rational transformation between two spaces, VII, 222—4; quartic surfaces, VII, 246; compound combinations, X, 243; biquaternions, XI, 458; syzygetic relations among the powers of linear quantics, XIII, 224—7; non-Euclidian geometry, XIII, 481.
- Close** : partitions of  $a$ , V, 62—5, 617; defined, V, 63.
- Close-planes** : the term, VI, 330, 583—5.
- Close-points** : the term, VI, 330, 339, 341, 583—5.
- Cnicnode** : the word, VI, 330, 334, 361, 583—5, XI, 228, 631, 633; quartic and quintic surfaces, VII, 245—51.
- Cnictrope** : the word, VI, 330, 334, 583—5, 591, XI, 228, 631, 633.
- Cobezoutians** : defined, II, 524.
- Cobezoutoids** : defined, II, 524—5.
- Cockle, Sir James** : resolvent product, IV, 309—13; on quintics, V, 53; theory of equations, XI, 520; invariants, XII, 390—1; criticoids, XIII, 366, 367—8.
- Codazzi, D.** : application of surfaces, XIII, 253—64.
- Coefficients** : of Legendre, I, 375—6; development of  $(1+n^2x)^{m/n}$ , XIII, 354—7.
- Cogredient** : the term, IV, 607—8, XIII, 46.
- Cohen, A.** : relative motion, IV, 537, 586; rotation of solid body, IV, 573, 586.
- Cole, F. W.** : on simple groups, XIII, 533.
- Colink** : the term, V, 521.
- Collins, M.** : Lagrange's theorem, II, 3; systems of circles, X, 566—7.
- Colour Groups** : diagrams representing, X, 328—330, 403—5; the term, XII, 639—41.
- Colours** : in maps, XI, 7—8.
- Colourset** : the term, XII, 641.
- Columns** : the term, XII, 353.
- Comberousse, C.** : polyhedra, IV, 609.
- Combescure, E.** : wave surfaces, XIII, 238.
- Combinants** : of quantics, II, 322; the term, II, 518, IV, 607—8, XIII, 46; and ternary quadratics, IV, 352.
- Combinatory Analysis** : magic squares, X, 38; compound combinations, X, 243—4; a problem of arrangements, X, 245—8; note on Mr Muir's solution, X, 249—51; the game of mousetrap, X, 256—8; Sylvester's work in, XIII, 47; (*see also* Partitions).
- Commutants** : the term, I, 584, II, 19, 26, IV, 594, 599—600, XIII, 46; property of, V, 495—7.
- Commutative** : the term, XII, 461; (*see also* Groups).

**COMOMENT—CONICS.**

84

- Comoment**: non-Euclidian geometry, XIII, 481—9.
- Compass**: Mascheroni's geometry of the, XII, 314—7.
- Complex** (*see* Surfaces).
- Complex Cone**: (cubic) defined, v, 402, 404, 551.
- Complexes of Lines**: IV, 618; through twisted quartic, XII, 428—31.
- Complex Multiplication**: in elliptic functions, XII, 556—7; (*see also* Multiplication).
- Complex Quantities**: logarithms of, VI, 14—8.
- Complex Variables**: and conformal representation, x, 316—23; Newton-Fourier theorem for, x, 405—6; (*see also* Function, Newton-Fourier theorem).
- Composition**: of quadratic forms, I, 532; of singularities, v, 619; of rotations, VI, 24—6.
- Compound Combinations** (*see* Combinatory analysis).
- Compound Singularities**: v, 525.
- Conchoid**: the term, XI, 460.
- Concomitant**: the term, IV, 607—8, XIII, 46.
- Concomitant-system**: of quintic, x, 342.
- Cone**: touching six lines, VIII, 401—3; formulæ for potentials of, IX, 266—7.
- Cones**: through cubic curve in space, III, 219—21; note on cubic, IV, 120—2; and cubic centres, IV, 173—8, 179—81; and cubic curves, v, 284—8; kinds of cubic, v, 401—15; and representation of curve, v, 552; circumscribed sextic, VII, 139; satisfying six conditions, VIII, 99—137; the term asymptotic, XIII, 232; characteristic  $n$  and theory of curves in space, XIII, 468—72.
- Configurations**: algebraic, by Hilbert, VI, 596.
- Conformal Representation**: IX, 609—11, XI, 442, XII, 104; by function  $\arcsin(x+iy)$ , x, 290—2; mechanical constructions, x, 406; example, XI, 38; theorem, XI, 78—81; and Schwarzian theory, XI, 169—76; imaginary quantities, XI, 258—60; (*see also* Orthomorphosis, Representation, Transformation).
- Congregate**: the word, x, 339, 345.
- Congruences**: in *Ency. Brit.*, XI, 628, 634—5; analytical theory, XIII, 228—30.
- Conic**: theorem of triangle and line, v, 100—2; theorem of eight points on a, v, 427—30; formula for intersections of line and conic, v, 500—4; four points on, v, 571; defined by five conditions, VII, 546, 552; through three points and with double contact, VII, 554; foci of, VII, 571; and four points, VII, 581, 587; construction, VII, 592; (2, 2) correspondence of points on, VIII, 14—21; and cubic, x, 605—7; Monge's differential equation, XII, 393; focals of quadric surface, XIII, 54.
- Conic-node**: the term, VI, 360.
- Conics, Analytical Theory of**: IV, 395—419; relating to single conic, IV, 396—402; ditto with point or line, IV, 402—12; ditto with tangent of conic of double contact, IV, 413; relating to two conics, IV, 416—9.
- Conics**: general theory of, I, 519—21; inscribed in a quadric surface, I, 557—63; in-and-circumscribed polygon, II, 142—4, IV, 295—9; two dimensional geometry, II, 575—83, 586—92; forms of equations of, III, 86—90; area of, and trilinear equation second degree, III, 143—8; normals of, IV, 74—7; of five-pointic contact of plane curve, IV, 207—39; which touch four lines, IV, 429—31; system having double contact, IV, 456—9, VII, 568; theorem in, IV, 481—3; touching curves, v, 31—2, 552; four inscribed in same conic and passing through same three points, v, 131—2; contact of, v, 552; and rectangular hyperbolas, v, 554; problem, v, 562, 582; tangents of, v, 578; intersection of, v, 582; triangle and, v, 593; and cubic, v, 608; drawing of, VI, 19; locus from two, VI, 27—34; theorem of four which touch same two lines and pass through same four points, VI, 35—9; which touch cuspidal cubic, VI, 249—53; contact of third order with given cuspidal cubic and double contact with given cubic, VI, 253—6; Zeuthen's forms for characteristics of conics which satisfy four conditions, VI, 256—8; correspondence, and those which satisfy given conditions, are at least arbitrary, VI, 268—71; five conditions of contact with a given curve, VI, 272—91; foci of, VI, 517—9, VII, 1—4; determined by

five conditions of contact, VII, 40; three, problem and solution, VII, 595; and absolute, VIII, 31—44; theorem of eight points on, VIII, 92—4; cuspidal, of centro-surface, VIII, 352—7; reciprocal of equation, VIII, 522—3; theory of confocal, VIII, 556—7; sets of four points on, X, 569; and lines, X, 602; degenerate forms of curves, XI, 218—20; the term, XI, 460; in *Ency. Brit.*, XI, 561—4; analytical geometrical note on, XII, 424;  $f$  and  $c$ , XIII, 11—2; non-existence of special group of points, XIII, 212; the nine-point circle, XIII, 517—9.

**Conics, Spherical:** theorem relating to, IV, 428; and stereographic projection, V, 106—9; (*see also* Polyzomal curves).

**Conics which pass through:** four points, III, 136—8; four foci of given conic, IV, 505—9; three given points and touch one line, V, 258—64; two given points and touch two given lines, VI, 43—50; two given points and touch given conic, VI, 245—9.

**Conic Torus:** the, IX, 519—21.

**Conjugate Integrals:** Hamiltonian, X, 113—5.

**Conjugates:** table of, and seminvariants, XIII, 303, 307.

**Connected Areas:** XI, 7.

**Connective:** of discriminant, II, 529.

**Connective Covariant of two Quantics:** defined, II, 515.

**Conormal Correspondence:** of vicinal surfaces, VIII, 301—8.

**Constants:** number of, in special equations, XI, 14—6.

**Constructive Geometry:** VII, 27.

**Contacts:** problem of, I, 522—31; the term, VII, 546.

**Content:** Ball on theory of, II, 606.

**Continuous Function:** the term, XI, 539.

**Contour:** lines, IV, 108—11, 609; defined, V, 63.

**Contracovariants:** defined, IV, 329.

**Contractible Squarewise:** the term, XIII, 179.

**Contragredient:** the term, IV, 607—8, XIII, 46.

**Contraprovectant:** defined, II, 514.

**Contraprovector:** the term, II, 514.

**Contrasect:** the term, XIII, 485.

**Contravariant:** the term, II, 320, XIII, 46; of ternary cubic, IV, 325.

**Convergence:** condition of uniform, XIII, 342—5.

**Converging Series:** product of, IX, 61.

**Convertible Matrices** (*see* Matrices).

**Convolution:** the term, VI, 461—2.

**Coordinates:** in general theory of geometry, II, 604—6; as functions of parameters, VI, 1—2; polyzomal curves, VI, 498—9, 537; trilinear, XI, 467; Plücker, XI, 467; degenerate curves, XI, 488—9; in *Ency. Brit.*, XI, 546—51, 566—7; illustrative of geometry, XI, 552—6; curvilinear, in *Ency. Brit.*, XI, 637; versus quaternions, XIII, 541—4.

**Coordinates of a Line:** X, 603, XI, 468.

**Coordinates of Points:** expressions for, V, 517—8; lines and planes, non-Euclidian geometry, XIII, 489—91.

**Coordinates, Six of a Line:** VII, 66—98, VIII, 401, X, 287, XII, 42—3, 321; introductory, VII, 66; definition and general notions, VII, 67—9; elementary theorems, VII, 69—73; geometrical considerations, VII, 73—5; linear relations between six coordinates, VII, 75—85; geometrical property of an involution of six lines, VII, 85; four given lines and twofold tractor, VII, 85—6; hyperboloid through three given lines, VII, 86—8; six coordinates defined as absolute magnitudes, VII, 88—9, 96—7; statical and kinematical applications, VII, 89—95; transformation of coordinates, VII, 95—6; formulæ of transformation, VII, 97—8.

**Coordinates, Spherical:** theory of, and systems of equations, I, 213—23.

## COORDINATES—CRUNODE.

86

- Coordinates, Transformation of:** I, 123—6, IV, 552—9, XI, 136—42; in *Ency. Brit.*, XI, 558—61, 573—6.
- Copfaffian:** the term, XIII, 406.
- Coriolis, G.:** motion of three bodies, IV, 541.
- Corpus:** Sylvester's theory of the, XIII, 47.
- Correspondence:** on cubic curves, I, 184, 190; homographic figures, I, 212; theory, VI, 263—91, X, 259—60, XI, 482; in-and-circumscribed triangle, VIII, 222—5; vicinal surfaces, VIII, 301—8; of two variables, IX, 94—5, XII, 104; geometrical representation of imaginary variables, X, 316—23; construction of a, XI, 38; quadric transformation between points and planes, XII, 100—1; of Cartesians, and generators of hyperboloid, XII, 587—9.
- Correspondence of Points:** V, 542—5, VI, 22, VII, 168—70, XI, 440; two on a curve, VI, 9—13; on a conic, VIII, 14—21; on surfaces, VIII, 200—8; and lines, VIII, 566.
- Cos-centre:** the word, XIII, 551.
- Cotes, R.:** central forces, IV, 517, 586.
- Cotterill, T.:** correspondence of points, VI, 22; problem of envelope and two circles, VII, 573; theorem of Geiser, IX, 506; goniometric problem, X, 295—7.
- Counter-barriers:** the term, X, 320.
- Counter Order:** the term, XIII, 268.
- Couples:** algebraic, I, 128—31.
- Cournot, A. A.:** motion of a body, IV, 583, 586.
- Covariantive Forms and Tables:** XI, 277—80;  $M$  to  $W$  of binary quintic, II, 282—309; aszygetic, to degree 18, VI, 149—52; 34 concomitants of ternary cubic, XI, 342—56; of binary sextic, XI, 372—6, 377—88; theory of tamisage, XI, 409—10.
- Covariants:** the term, I, 577, 589, II, 224, IV, 594, 605, X, 340, XIII, 46; determined by differential equations, II, 164—78; theory, II, 164—78; of binary cubic, II, 189, 260—2; binary quadratic, II, 189; binary quartic, II, 190, 262—4; aszygetic, II, 250; binary quintic, II, 269; of cubic, analogous to invariants of quartic, II, 553; bibliography, II, 598—601; of degree 6, VI, 148—53; of binary cubic, geometrical interpretation, VII, 332—3; the terms aszygetic and irreducible, VII, 336; theory of number of irreducible, VII, 336—7; also new formulæ for aszygetic, VII, 337—40; also 23 fundamental, VII, 341—8; Gordan's proof for the number, VII, 348—53; theory founded by Cayley, VIII, xxix—xxx; his work, VIII, xxx—xxxii; as transvectants, VIII, 404—8; connected with an algebraical operation, IX, 537—42; derivatives of three binary quantics, X, 278—86; theorem, X, 430—1; a formula, XI, 122—4; formula and Schwarzian derivative, XI, 184—5; in geometry, XI, 474; Sylvester on, XIII, 47; a hyperdeterminant identity, XIII, 210—11; theory of derivation connected with particular operators, XIII, 329—32; (*see also* Invariants, Linear Transformation, Seminvariants).
- Cox, H.:** Taylor's theorem, VIII, 493.
- Cox, H., Jun.:** non-Euclidian geometry, XIII, 481.
- Cramer, G.:** determinants, I, 63; curve classification, V, 354; transformation of plane curves, VI, 1.
- Creedy, C.:** tangential of cubic, II, 558; calculations by, III, 361; elliptic motion, IV, 522, 586.
- Cremona, L.:** on Steiner's quartic surface, V, 423; general theory of correspondence, VI, 22—3; Casey's equation, VI, 66—7; scrolls, VI, 327—8, VII, 245—51; polyzomal curves, VI, 575—6; rational transformation, VII, 189, 200, 207, 222, 253—5, XI, 482, 484; theory of curve and torse, VIII, 72, 76—9, 87—91; geometric transformation, X, 611—2.
- Critic Centres** (*see* Involution of Cubic Curves).
- Criticoids:** and invariants, XII, 390; and reciprocants, XIII, 366—7; of Cockle, XIII, 366—7.
- Critic Points and Lines:** the term, X, 311—5.
- Crofton, M. W.:** polyzomal curves, VI, 507; Cartesian curves, VII, 582.
- Cross-points:** the term, X, 317.
- Crunodal:** the term, V, 402, 551, XI, 228.
- Crunode:** defined, IV, 181, V, 295, 521, XI, 630.

**Crystals**: biaxial and ray planes, ix, 107—9.

**Cube**: axial systems, v, 531—9; automorphic function for, xi, 169, 179—83, 212—6.

**Cubic**: canonical form of binary, ii, 542; equation of differences for, iv, 242, 279; ternary, iv, 325—41; and tables, iv, 333—41; the term, iv, 604; resultant of two binary, v, 289—91; aszygetic covariants of binary, vii, 338—9; automorphic transformation of binary cubic, xi, 411—6; (*see also* Binary and Ternary Cubics).

**Cubic Centres**: of lines, v, 73—6.

**Cubic Cone**: kinds of, v, 401—5, 551, 553; anharmonic property, v, 411—2.

**Cubic Curve Classification**: v, 354—400, viii, xxxviii; seven head divisions, v, 355—6; their equations, v, 356—9; thirteen divisions, v, 360—1; notion of group, v, 361; osculating asymptotes, v, 361—3; Newton's classification, v, 364—6, xi, 464; Plücker's, v, 366—8; theory of groups, v, 368—9; groups of hyperbolas  $\Delta$ , v, 369—70; hyperbolas  $\Delta$  redundant, v, 370—6; ditto defective, v, 376—88; hyperbolas  $\circ$ , v, 388—9; ditto redundant, v, 389—90; ditto defective, v, 390—1; groups of parabolic hyperbolas, v, 391—4; of central and parabolic hyperbolisms, v, 394; groups of divergent parabolas, v, 395; trident curve and cubical parabola, v, 395; division into species, Newton and Plücker, v, 396—9.

**Cubic Curve Memoirs**: first, i, 183—9, 586; remarks, i, 190—4, 586; second memoir, ii, 381—416, iv, 188; definitions, ii, 382—3; theorems relating to conjugate poles, ii, 383—5; their proof, ii, 385—96; geometrical definition of Quippián, ii, 396—7; theorems, ii, 397—403; formulæ for intersection of curve and line, ii, 404—5; formulæ for satellite point and line, ii, 405—9; theorems relating to satellite point, ii, 409—12; first polar point of cubic, ii, 412—5; recapitulation of geometrical definitions of Pippian, ii, 416.

**Cubic Curves**: tangential of, ii, 558—60; cones through, iii, 219—21; note on, iv, 120—2; five pointic contact, iv, 231—6; ninth point of intersection of those passing through eight given points, iv, 495—504; twisted, v, 1; sextactic points of plane, v, 233—5; and cones, v, 401—15, 551, 553; inflexions of, v, 493—4, xi, 473; in connexion with quintics and quartics, v, 580; problem, v, 586; derivation of points, vi, 20; intersection of, vi, 20; in pencil of six lines, vi, 105—15, 593—4; nodal, vi, 171—4; foci of circular, vi, 521—2; theory of circular, vi, 526—8; symmetrical circular, vi, 549—50, 550—3; quartic and three, vii, 546; points on, vii, 549; and Cartesian curves, vii, 556; rectangular, vii, 591; mechanical description, viii, 147—50; residuation in regard to one, ix, 211—4; problem and solution, x, 592—4; equation of, x, 603; and conic, x, 605—7; Abel's theorem applied to, xi, 27—8; degenerate, xi, 220; date of theory, xi, 449; forms and classification, xi, 478—80; circular, xi, 481; systems of, xi, 487; Abel's theorem, xii, 30; elliptic functions, xii, 35—7; as ground-curve in Abel's theorem, xii, 38, 109—216; twisted, on quadric surface, xii, 307—10; notion of, xiii, 79—80; and non-existence of a special group of points, xiii, 212.

**Cubic Equations**: solution of, ii, 542; Tschirnhausen's transformation, iv, 364—7, 377; equation of squared differences, iv, 463—5; Sturmian constants, iv, 473—7; relation between roots, vii, 548; solution by radicals, x, 9; constants of, xi, 556; note on, xii, 421—3; Cardan's solution, xii, 299; on two, xiii, 348—9.

**Cubic Forms**: letters on, iii, 9—12.

**Cubic Identity**: problem, v, 597.

**Cubic Scrolls** (*see* Scrolls).

**Cubic Seminvariants**: generating function, xiii, 306.

**Cubic Surfaces Memoir**: vi, 359—455, 595—6; Introductory, vi, 359; twenty-three cases, explanations, and tables of singularities, vi, 359—63; determination of number of certain singularities, vi, 364—5; lines and planes of cubic surface, facultative lines, diagrams, vi, 365—6; different kinds of axis, vi, 367; determination of reciprocal equation, vi, 368—70; explanation of sections of memoir, vi, 370—1; equations,  $I=12$ , vi, 371—83;  $12-C_2$ , vi, 383—90;  $12-B_3$ , vi, 391—6;  $12-2C_2$ , vi, 397—402;  $12-B_4$ , vi, 403—7;  $12-B_3-C_2$ , vi, 407—11;  $12-B_5$ , vi, 411—8;  $12-3C_2$ , vi, 418—

**CUBIC—CURVES.**

88

22;  $12-2B_3$ , VI, 422—6;  $12-B_4-C_2$ , VI, 426—8;  $12-B_6$ , VI, 429—30;  $12-U_6$ , VI, 431—3;  $12-B_3-2C_2$ , VI, 433—6;  $12-B_5-C_2$ , VI, 437—9;  $12-U_7$ , VI, 439—40;  $12-4C_2$ , VI, 441—2;  $12-2B-C_2$ , VI, 443—4;  $12-B_4-2C_2$ , VI, 445—6;  $12-B_6-C_2$ , VI, 447—8;  $12-U_8$ , VI, 448—9, 451—5;  $12-3B_3$ , VI, 449—50; synopsis of foregoing, VI, 450; cubic scrolls, VI, 451.

**Cubic Surfaces**: triple tangent planes, I, 445—56, 589; skew, v, 90—4; delineation of scrolls, v, 110—2; nodal curve of developable from quartic equation, v, 135—7; theory, v, 138—40; five given lines on, VII, 177—8; double sixers, VII, 316—29; and tetrahedra, VII, 607; Wiener's model with 27 real lines, VIII, 366—84; in *Ency. Brit.*, XI, 633.

**Cubic Transformation of Elliptic Functions**: III, 266—7, VII, 44—6, x, 46, 58, XII, 518—22, 555, 556—7; geometric illustration, IX, 522—6.

**Cubi-Cubic Curves**: in space, v, 18—9.

**Cubinvariants**: of binary quartic, I, 94; of quantic, II, 516; the term, IV, 606; of quadri-quadric function, XIII, 67—8.

**Cuboid**: potential of, IX, 272, 274—5, 278—80.

**Cumulant**: the word, IV, 600—1.

**Cunningham, A.**: on number of terms in a determinant, x, 579—80.

**Curtate**: the term, XI, 155.

**Curvature**: lines of, on ellipsoid, I, 36—9; of plane curve at double point, IV, 466—9; of surfaces, IV, 466—9; geodesic, XI, 323—30; (*see also* Curves of Curvature, Orthogonal Surfaces).

**Curves**: and developables, I, 207—11, 485, 586—7, 589; and two dimensional geometry, II, 569—83; partial branch of, v, 425; reciprocation, v, 505—10; representation by cone and monoid surface, v, 552; nodal, spinode and cuspidal, of cubic surfaces, VI, 450, 595; and space of  $m$  dimensions, VI, 456—7; correspondence of two points on, VII, 39; graduation, VII, 426; mechanical description, of, VIII, 138—44, 147—50, 151—5, x, 576; bicyelic chuck for, VIII, 209—11; penultimate forms, VIII, 258—61, 262—3; property of curve and torse, VIII, 520—1; coordinates and equations, x, 546; degenerate forms, XI, 218—20, 487—9; abstract geometry, XI, 441—2; in *Ency. Brit.*, XI, 460—89, 572—3, 579—80; and theory of equations, XI, 501; and function, XI, 540—1; and solid geometry, XI, 569; quadrature of, XI, 641—2; minimal surfaces, XIII, 41; orthotomic, of a system of lines in a plane, XIII, 346—7; (*see also* Correspondence, Cubic Curves, Nodal Curves, Polyzomal Curves).

**Curves, Algebraic**: I, 46—54, 584.

**Curves, Bicursal**: VIII, 181—7.

**Curves, Classification of**: v, 613—7; (*see also* Cubic Curve Classification).

**Curves, Excubo-quartic**: v, 282.

**Curves in Space**: analytical representation, IV, 446—55, 490—5, 616—8, VII, 66, XI, 9—13; defined by conoid and monoid surfaces, v, 7—20, 552, 553, 613; quartic, v, 11—5; quintic, v, 15—6, 24—30, 552, 553, 613; quadri-cubic, v, 16; quadri-quartic, v, 17; cubi-cubic, v, 18—9; Halphen's characteristic  $n$  in theory of, XIII, 468—72.

**Curves, Intersections of**: I, 25—7, 583, XII, 500—4; real, IX, 21.

**Curves of Curvature**: near umbilicus, VII, 330—1; on surfaces, VIII, 97—8, 145—6, 264—8; *Ency. Brit.*, XI, 628, 635—6; wave surface, XII, 249; surfaces with spherical, XII, 601—38.

**Curves of Striction**: I, 234.

**Curves, Opposite**: v, 468.

**Curves, Parallel**: envelopes and surfaces, IV, 123—33, 152—7, 158—65; and evolutes, VIII, 31—5; theory of, x, 260; the critic, in solar eclipses, x, 311—5.

**Curves, Pedal**: v, 113—4.

**Curves, Penultimate Quartic**: VIII, 526—8.

**Curves, Penumbral**: geometrical theory of projection, VII, 483, 488—9, 489—92.

**Curves, Plane**: double tangents of, IV, 186—206; conic of five-pointic contact of, IV, 207—39;

- curvature at double point, IV, 466—9; higher singularities, V, 424—6, 520—8, 619; correspondence of points on, V, 542—5; transformation, VI, 1—8, 593, VIII, 387; notion of, of given order, XIII, 79—80.
- Curves, Plane, sextactic points of:** V, 221—57, 618—9; condition for point, V, 222—5; notations and remarks, V, 225—6; first transformation, V, 226; second, V, 227—8; third, V, 228—9; fourth and final form, V, 229—33; application to cubic, V, 233—5; proof of identities, V, 235—7; Jacobian formula, V, 237—8; proofs of equations and identities, V, 239—47; appendix, V, 247.
- Curves, Poloid:** IV, 571.
- Curves, Rhizic:** IX, 34.
- Curves, Serpoloid:** IV, 571.
- Curves, Sextic:** VII, 256—7, VIII, 138—44, X, 612.
- Curves, Symmetric:** I, 473.
- Curves, Theory of:** and elimination, I, 337—51, V, 162—7, 416—20; evolution, XI, 449—51, XII, 102—3, 290—1.
- Curves, Theory of, and Torse:** VIII, 72—91; explanations and notation, VIII, 72—4; Plücker-Cayley equations, VIII, 74, 75—6, 80—1; Salmon-Cremona equations, VIII, 74, 76—9, 87—91; geometrical theory of foregoing relations, VIII, 79—80; tables, VIII, 81—4; nodal curve  $x$ , VIII, 84—7.
- Curves, Three-bar:** IX, 551—80, 585.
- Curves, Transformations of:** I, 471—5, 476—80; scalene, IX, 527—34.
- Curves, Triangular:** VII, 59.
- Curves, Twisted Quartic:** XII, 428—31.
- Curves which satisfy given conditions:** VI, 191—262, 594, VII, 40; Introductory, VI, 191; previous memoirs, VI, 191—2; quasi-geometrical representation of conditions, VI, 193—200; Chasles' and Zeuthen's researches, VI, 200—26; extensions of de Jonquières, VI, 226—42; form of equation of curves of a series of given index, VI, 242—3; line-pairs which pass through three given points and touch a given conic, VI, 244; conics which pass through two given points and touch given conic, VI, 245—9; conics which touch cuspidal cubic, VI, 249—53; conics which have contact of third order with given cuspidal cubic and double contact with given cubic, VI, 253—6; Zeuthen's forms for characteristics of conics which satisfy four conditions, VI, 256—8; question from de Jonquières' formula, VI, 258—62; the principle of correspondence, VI, 263—91; (introductory, VI, 263—4; correspondence of two points on a curve, VI, 264—8; application to conics which satisfy given conditions, one at least arbitrary, VI, 268—71; five conditions of contact with a given curve, VI, 272—91).
- Curve Tracing:** Cayley's liking for, VIII, xxxix; mechanism, VIII, 179—80, XIII, 515—6; importance, XI, 461; order of, XI, 461.
- Curvilinear Coordinates:** XI, 330, XII, 1—18; surfaces divisible into squares, VIII, 146; geodesic lines, VIII, 156—67; curves of curvature, VIII, 264—8; orthogonal surfaces, VIII, 269—91.
- Cusp:** of Cartesian at circular points at infinity, I, 589; synonymous with spinode, II, 28, IV, 22, 27; of second kind or node-cusp, V, 265—6, 618; order of plexus for, V, 309—12; the term, XI, 468.
- Cuspidal:** defined, V, 403, 551, VII, 244.
- Cuspidal Conic:** of centro-surface, VIII, 352—7.
- Cuspidal Cubic:** VII, 561.
- Cuspidal Curves:** and cubic surfaces, VI, 450; (*see also* Cubic Surfaces, Surfaces).
- Cuspidal Isochronic:** the term, VII, 473.
- Cuspidal Locus:** in singular solutions, VIII, 533.
- Cyc:** the abbreviation in groups, XIII, 119.
- Cyclide:** of Dupin, V, 467, XII, 615; the term, VII, 246, VIII, 262, IX, 64—5; and anchor ring, IX, 18; on, IX, 64—78; the parabolic, IX, 73—8; in *Ency. Brit.*, XI, 634.
- Cycloid:** the term, XI, 447.

## CYCLOTOMY—DERIVATION.

90

**Cyclotomy**: (Kreistheilung), XI, 58, 86.**Cylinder**: in *Ency. Brit.*, XI, 572—3; Archimedes' theorem for surface, XII, 56—7.**d'Alembert, J. le R.**: rotation of solid body, IV, 567, 586; geometric paradox, XII, 305—6.**Dandelin, G. P.**: theory of, and on caustics, II, 339—40; wave surface, IV, 433—4.**Darboux, G.**: powers of circles and spheres, I, 581; the torus, VII, 247; quartic surfaces, VIII, 262; cyclide, IX, 64; continuous function, XI, 539; curves of curvature, XII, 615; quartics, XIII, 13.**Davis, W. Barrett**: calculations by, III, 361, IV, 376; quantic covariants, VII, 335; Sohnke's modular equations, IX, 543.**Déblais**: theory of, XI, 417—20, 449, 587.**de Bruno, Faà**: invariants of degree 12 belonging to quintic, II, 314; symmetric functions, II, 602; canonical forms, IV, 52; elimination, IV, 608.**Decadianome**: the term, VII, 134; and symmetroid, VII, 256.**Decapitation**: and seminvariants, XII, 248—50.**Decomposition**: linear differential equations and theory of, XII, 402, 403—7.**Dedekind, J. W. R.**: probabilities, II, 594—8, V, 80; modular function, XIII, 338—41.**Def**: the abbreviation in groups, XIII, 120.**Deficiency**: and genus of curve, V, 467, 517, 619; of curves, V, 618, VIII, 391, XI, 450; the term, VI, 2; and transformation, VI, 3, XI, 482—5; the term applied to surface, VI, 356; of certain surfaces, VIII, 394—7, XI, 230; surfaces of negative, VIII, 397; of sextic curve, IX, 504—7; of curve and Abelian integrals, XI, 30—6.**Definite Integrals**: with complex variables, I, 181—2, 310; differentiation and evaluation, I, 267—72, 587; on *a*, IV, 28—9; note on Glaisher's paper, VIII, 1; note on two, IX, 56—63; (*see also* Attractions, Potentials, Prepotentials).**Definitions** (*see* the word desired).**Deformation**: the term, I, 234; of hyperboloid, XI, 66—7; of skew surfaces, XI, 317—22, 331; (*see also* Surfaces).**Degeneracy**: of surfaces, V, 98—9; of scrolls, V, 201—3; of curves, XI, 218—20.**Degen's Mathematical Tables**: IV, 40, IX, 478—9, X, 586; report of British Association Committee, XIII, 430—67.**Deg-order**: the term, X, 339.**Degrees**: of quantics defined, II, 221.**Degrees, Honorary**: conferred on Cayley, VIII, xx—xxi; conferred on Sylvester, XIII, 43.**de Jonquières, E.**: cubic curves, I, 586, IV, 496; on curves, IV, 454; curves which satisfy given conditions, VI, 191, 192, VII, 41—3; form of equation of curves of a series of given index, VI, 242—3; question from formula, VI, 258—62; points on cubic curve, VII, 550, 553; correspondence, XI, 486.**de la Goupillière, H.**: inertia, IV, 566.**de la Gournerie, M.**: tetrahedral scrolls, VII, 48—53; scrolls, VII, 54; quartic and quintic surfaces, VII, 246, 247, 251; torus, VIII, 25; octic surfaces, X, 81.**Delambre, J. B. J.**: Tables du Soleil, III, 474.**Delaunay, C. E.**: lunar theory, VII, 357, 372, 376, 528—33, 534, IX, 180, XIII, 206—7.**de Morgan, A.**: root in every algebraic equation, IV, 116—9; root limitation, IX, 39; series, XI, 623, 627; and Sylvester, XIII, 45.**Denumerant**: illustrated, IV, 169—70.**Denumerate**: defined, IV, 241.**Departure Point**: in lunar theory, III, 19, 270, 295.**Derivation**: of points of cubics, VI, 20; and Übereinanderschlebung, VII, 348; and seminvariants, XIII, 362—5.



- Derivational Function**: the term, I, 63.
- Derivations**: extension of Arbogast's method, II, 257, IV, 265—71, 272—5, 609, XI, 55; binomial theorem and factorials, VIII, 463—73.
- Derivatives**: and hyperdeterminants, I, 95; of point on cubic, IV, 231; of three binary quantics, X, 278—86; and covariants, X, 340, 377—94; of a function, X, 590—2; in binary forms, XI, 272; (*see also* Schwarz).
- de St Laurent, T.**: caustic by reflexion, I, 273—5.
- Desboves, A.**: planetary perturbation, III, 185, 203; problem of two centres, IV, 532, 586.
- Descartes, R.**: ovals of, and transformation of curves, I, 478, 479—80, 589; oval of, III, 66; formulæ in *Epistolæ*, IV, 512; geometry of, XI, 437; (*see also* Cartesians).
- Determinants**: applied to distances of points, I, 1—4, 581, IV, 510—2; Pascal's theorem, I, 43—5; the term, I, 63; theory of, I, 63—79; theory of linear transformations, I, 80—94, 584; of vis viva, I, 284; note on hyperdeterminants, I, 352—5, 588; geometrical reciprocity, I, 377—82; "skew" and "symmetric," I, 410—3; history, I, 581; multiplication, I, 581, XI, 495; value of certain, III, 120—3, IV, 460—2; the term, IV, 594, 596—9; and Pfaffian, IV, 600; development of, V, 45—9; tables of binary cubic forms for negative, VIII, 51—64; Smith's Prize dissertation, VIII, 551—5; symmetrical, IX, 185—90, X, 579; notation, X, 95—7; theorem in, X, 265—6; in *Ency. Brit.*, XI, 490—7; decomposition, XI, 495—6; theory of numbers, XI, 604—9; (*see also* Hyperdeterminants, Skew Determinants).
- Determinator**: defined, II, 59.
- Determinirende**: (indicial), and differential equations, XII, 398, 401, 453.
- Developables**: and curves, I, 207—11, 586—7; the term, I, 486, XI, 573; from two quadrics, I, 486—95; from quintic curve, I, 500—6; planar, I, 505; from quartic, V, 135—7; prolessians, V, 267—83; quartics, V, 268—71; general theory, V, 271—2; special quintic, V, 272—8; special sextic, V, 279—83; reciprocation of quartic developable, V, 505—10; a special sextic, V, 511—9; sextic, and sextic surfaces, VI, 87—100; focals of a quadric surface, XIII, 51—4; (*see also* Torse).
- Development**: of factorial, II, 98—101; coefficients in powers of  $(1+n^2x)^{m/n}$ , XIII, 354—7.
- Dew-Smith, A. G.**: portrait of Cayley, XI (frontispiece).
- Diagonals**: and partitions of a polygon, XIII, 93—113.
- Diagrams**: the term, VII, 405; of planet's orbit from three observations, 5 plates, VII, to face 478; solar eclipse, VII, to face 492; geodesic lines on ellipsoid, VII, 510; coloured, representing groups, X, 328—30; transformation of elliptic functions, XI, 26; seminvariants, and solution by square-, XIII, 288—98; (*see also* Tables).
- Diameter**: as used by Newton, V, 362.
- Diametral planes** (*see* Planes).
- Dianome**: the term, VII, 133, 148; (*see also* Quartic Surfaces).
- Diaphoric**: the term, XI, 156.
- Dickinson, L.**: portraits of Cayley, VI (frontispiece), VII (frontispiece), VIII, XX.
- Differences**: equation of squared, for cubic, IV, 463—5; relation between certain products of, X, 293—4; on a functional equation, X, 298—306; (*see also* Equation of Differences).
- Differential Equation Memoir**: X, 93—133; introductory, X, 93—4, 94—5; notations, X, 95—7; dependence of functions, X, 97; general differential system, X, 98—102; the Multiplier, X, 102—5; Pfaffian theorem, X, 106; Hamiltonian system, derived from general system, X, 106—7; Poisson-Jacobi theorem, an identity in regard to functions  $(H, \Theta)$ , X, 108—9; peculiar to Hamiltonian system, X, 110—3; conjugate integrals of Hamiltonian system, X, 113—5; Hamiltonian system—the function  $V$ , X, 115—8; partial differential equation  $H=\text{constant}$ , X, 119—25; examples, X, 125—32; partial differential equation containing the dependent variable, reduction to standard form, X, 132—3.
- Differential Equations**: and lines of curvature of ellipsoid, I, 36—9; dynamical, I, 276—84; Jacobi's

**DIFFERENTIAL—DOSTOR.**

92

system of, I, 366–9; Jacobi on theory, III, 174; theorem of Jacobi on Pfaff's problem, IV, 359–63; singular solutions, IV, 426–7; transformation, IV, 574, V, 78–9; umbilici, V, 115–30; solution when algebraical, VII, 5–7; supposed new integration, VII, 36; note on one, VII, 354–6; pair in lunar theory, VII, 535–6, 537–40; integration by series, VIII, 458–62; Euler's, IX, 592–608; and theory of elliptic functions, X, 20; and sides of quadrangle, X, 33–5; theory of partial, X, 134–8; elliptic and single theta functions, X, 422–9; hypergeometric series, XI, 17–25; Abel's theorem, XI, 27–8; new formulæ for integration of Euler's equation, XI, 68–9; mathematics and physics, XI, 449; connected with elliptic functions, XII, 30–2; Briot and Bouquet's theory, XII, 432–41; of circular functions, XII, 580; a diophantine relation, XII, 596–600; and construction of Milner's lamp, XIII, 3–5; Kummer's, of third order, XIII, 69–73; on a partial, XIII, 358–61; Richelot's integral of Euler's, XIII, 525–9; (*see also* Partial Differential Equations, Riccati, Schwarz, Singular Solutions).

**Differential Equations, Linear**: invariants of one, XII, 390–3; general theory, XII, 394–403, 444–52, 453–6; theory of decomposition, XII, 403–7.

**Differential Equations of First Order**: theory of singular solutions, VIII, 529–34, X, 19–24.

**Differential Invariants** (*see* Invariants).

**Differential Operators**: VII, 8.

**Differential Relations**: of double theta-functions, X, 559–65.

**Differentiation**: evaluation of definite integrals, I, 267–72, 587; formulæ for, IV, 135–49; fractional, XI, 235–6.

**Dimensions in Geometry** (*see* Geometry).

**Dimidiate**: the term, XIII, 119.

**Dimidiation**: the term, XIII, 122.

**Diophantine Differential Relation**: XII, 596–600.

**Diptich**: the term, XII, 596.

**Dirichlet, G. L.** (*see* Lejeune-Dirichlet).

**Director, Nodal** (*see* Nodal Director).

**Directrix**: and scrolls, VII, 60; and the absolute, XIII, 481–9, 501; kinematics of a plane, XIII, 505–6.

**Discriminant**: and invariant, I, 584; defined, II, 176, IV, 603, VI, 466–7; of quantics, II, 320; the sign  $\square$ , II, 528; special, connected with curve, V, 163; of quintic, problem, V, 592; of binary quantic, VII, 303, IX, 16–7; example of a special, VIII, 46–7; (*see also* Quantics).

**Discriminant Locus**: the term, VI, 198.

**Displacement**: the term in Abel's theorem, XII, 110, 157–62.

**Distance**: general theory of, II, 561, 583–92, 604–6, V, 550; notion of, in analytical geometry, V, 550; the term, VI, 497; angular, of two planets, VII, 377–9; Cayley and Klein on theory, VIII, xxxvi–vii; general notion, VIII, 31; Euclidian geometry, XI, 435–7; non-Euclidian geometry, XIII, 480–504; (*see also* Points).

**Distribution of Electricity**: on spherical surfaces, IV, 92–8, 99–107, XI, 1–6.

**Distributively**: the term, VI, 459.

**Disturbing Function**: in lunar theory, III, 293–308, 319–43; in rotation of solid body, III, 486.

**Divisors**: tables of, IX, 462–70.

**Dodecahedron**: construction, IV, 82–3; axial systems, V, 531–9; as regular solid, X, 270–3; automorphic function for, XI, 169, 179–83, 184, 212–6.

**Donkin, W. F.**: expansions in multiple sines, I, 583; differential equations, dynamical, III, 191–7, 203–4 344; transformation of trigonometric series, III, 567; attractions, III, 567; a definite integral, IV, 29 formulæ for differentiation, IV, 135–49; central forces problem, IV, 521; spherical pendulum, IV, 534, 536, 586; dynamical problems, IV, 547, 586; elimination of nodes in three bodies, IV, 551, 586; rotation of solid body, IV, 578, 586.

**Dostor, G.**: polyhedra, IV, 609.

- Dots**: notation for lines and planes of cubic surfaces, VI, 365—6, 373—449; and seminvariants, XIII, 267.
- Double Algebra**: XII, 465.
- Double Contact**: conics having with each other, IV, 456—9.
- Double Point**: the term, VI, 1; on ground-curve, XII, 110, 129.
- Double Pyramid** (*see* Polygons).
- Double-Sixer**: and cubic surfaces, VI, 372, VII, 316—29; construction, VIII, 366—84.
- Double Tangents** (*see* Bitangents).
- Double Theta Functions**: x, 155—6, 166—79, 180, 422—9, 474—5, 497, 565; in connexion with 16-nodal quartic surface, x, 157—65; memoir on, x, 184—213; (Part I, preliminary investigations, x, 184—9; Part II, the double theta functions, x, 189—213); addition of, x, 455—62; evolution, XI, 454; transformation, XII, 358—89; (*see also* Theta functions).
- Doubly Infinite Products**: I, 120—2, 132—5, 136—55, 156—82, 585, 586, x, 492—4, XI, 46, XII, 50—5; and doubly periodic functions, II, 150—63; and definite integrals, IX, 60; transformation of, x, 494—7.
- Doubly Periodic Functions**: I, 156—82; and doubly infinite products, II, 150—63; and definite integrals, IX, 61; the term, XI, 530.
- Drawing**: geometrical, VI, 19; of quartic curves mechanically, VIII, 151—5; curves generally, VIII, 179—80; (*see also* Representation).
- Droop, H. R.**: isochronism of circular hodograph, III, 265; central forces problem, IV, 520, 587.
- Duality**: in geometry, II, 561—2, 568, XI, 450, 467.
- Du Bois-Reymond, P. L.**: uniform convergence, XIII, 343.
- Dumas, W.**: spherical pendulum, IV, 534, 587.
- Dupin, C.**: cyclide of, v, 467, IX, 64, XII, 615; quartic and quintic surfaces, VII, 246; theorem of, VIII, 264—8, 562, IX, 84—9.
- Duplication of Groups**: x, 149—52.
- Durège, H.**: Landen's theorem, XI, 339.
- Durfee, W. P.**: symmetric functions, II, 602—3.
- Dynamics**: differential equations of, I, 276—84; a class of problems, IV, 7—11; similarity of two dynamical systems, VIII, 558—63; Lagrange's general equation in, IX, 110—2, 198—200; general equations in, IX, 215—7; and time, XI, 444; transformation of coordinates, XI, 575.
- Dynamics, Recent Progress in Theoretical**: III, 156—204, IV, 514; introduction, III, 156—7; Lagrange, *Mécanique Analytique*, III, 157—8, 201, 202; Lagrange, equations of motion, III, 158, 200; lunar theory, III, 158—9; Poisson, planetary theory, III, 159, 201; Laplace's theory, III, 159, 201; Lagrange's planetary theory, III, 159—61, 162—3, 201; Lagrange, variation of arbitrary constants in mechanical problems, III, 161—5, 200; also Poisson, III, 163—5, 200, 201, 202; Cauchy, differential equations, III, 166; Hamiltonian method of dynamics, III, 166—74, 200, 202; its relations to Lagrange's, III, 171—3, 200; and Poisson, III, 173—4, 200; Jacobi, calculus of variations and differential equations, III, 174—82, 200, 202; *De Motu Punkti Singularis*, III, 182—3, 202; problem of three bodies, III, 183; Jacobi, *Theoria Novi Multiplicatoris*, III, 183—5; Jacobi, theory of ideal coordinates, III, 185; Liouville, equations of motion, III, 185; Desboves, planetary perturbation, III, 185, 203; Serret, integration of differential equations, III, 185—6, 203; Sturm, integration of dynamical equations, III, 186, 203; Ostrogradsky, dynamical equations, III, 186, 203; Brassinne, differential equations, III, 186—7, 203; Bertrand, integrals to mechanical problems, III, 187, 203; and integration of differential equations, III, 188—9, 203; and *Mécanique Analytique*, III, 189—90, 203; Brioschi, *Sulla Variazione*, and *Teorema di Meccanica*, III, 190, 203; Liouville, integration of differential equations, III, 191—2, 203; Donkin, dynamical differential equations, III, 191—7, 203—4; Bour, integration of differential equations of analytical mechanics, III, 197—8, 204; Liouville on Bour's memoir, III, 199, 204; Brioschi, *Degli Integrali di un Problema di Dinamica*, III, 199—200, 203; Bertrand, integrals of several mechanical problems, III, 200, 203; summary, III, 200.
- Dynamics, Report on Progress of Solution of Certain Problems**: IV, 513—93; introductory, IV,

**EARTH—ELLIPSOIDS.**

94

513—5; rectilinear motion, IV, 515—6; central forces, IV, 516—26; elliptic motion, IV, 521—4; problem of two centres, IV, 524—32; spherical pendulum, IV, 532—4; motion as affected by the Earth and relative motion generally, IV, 534—7; motion of single particle, IV, 537—8; motion of three mutually attracting bodies in a right line, IV, 538—40; motion of three bodies, IV, 540—1; motion in resisting medium, IV, 541; integration of equations of motion, IV, 542—6; memoirs by Jacobi, Bertrand and Donkin, IV, 546—7; problem of three bodies, IV, 548—52; transformation of coordinates, IV, 552—9; principal axes and moments of inertia, IV, 559—66; rotation of solid body, IV, 566—80; kinematics of solid body, IV, 580—2; rotation round fixed point, IV, 582—3; other cases of the motion of a solid body, IV, 583—4.

**Earth, The:** rotation of, III, 485, IV, 534—7; (*see also* Gravity).

**Eclipses** (*see* Solar Eclipses).

**Edge:** defined, v, 63.

*Eindeutig:* (Uniform function), XII, 433.

**Eisenstein, F. G.:** linear transformations, I, 90, 101, 111, 113—6, 585; hyperdeterminants, I, 353, II, 598—601; elliptic functions, I, 586; cubic forms, III, 9; quadratic residues, III, 39—43; finite differences, IV, 263; mathematical tables, IX, 492—3; “development of an idea of,” x, 58—9; development of  $(1+n^2x)^{m/n}$ , XIII, 357.

**Elastic Strings:** problem with, III, 78—9.

**Electricity:** distribution on spherical surfaces, IV, 92—8, 99—107, x, 299, 307, XI, 1—6.

**Elements:** Jacobi’s canonical, III, 77; of arc, x, 235—7; a reduction to elliptic integrals, x, 239—42.

**Eliminant:** the term, IV, 597; of two quantics, XI, 100—2.

**Elimination:** and theory of curves, I, 337—51, v, 162—7, 416—20; from connected equations, I, 370—4; and linear transformations, I, 457; theorem of Schläfli, II, 181—4; a result of, III, 214—5; general theorem, IV, 1—4; Bezout’s method, IV, 38—9, v, 555—6; of nodes in three bodies, IV, 551; the term, IV, 594; text-books on, IV, 608; note on, v, 157—9; problem, VI, 40—2, VIII, 22—4; the resultant of a system of two equations, VI, 292—9; theorem, IX, 43—4; formula of, XI, 100—2; theory of equations, XI, 490; a problem of Sylvester’s, XIII, 545—7.

**Ellipse:** curves parallel to, IV, 123—33, 152—7; and circle, v, 561; foci of, v, 586; and quadrilateral, v, 604; circles of curvature, VII, 555, XIII, 537; potential, IX, 281—90; negative pedals, x, 576; cubic curves, XI, 478; in *Ency. Brit.*, XI, 561—4; focals of quadric surface, XIII, 54; and epitrochoid, XIII, 82—7; orthomorphosis into a circle, XIII, 188—9, 422—4.

**Ellipsoid, Attraction of:** I, 388—91, 432—44, 582, VII, 380—3, XI, 448; Jacobi’s method, I, 511—18; Gauss’s method, III, 25—8, 149—53; Laplace’s method, III, 53—65; Rodrigues’ method, III, 149—53; theory of, III, 154—5; and terminated straight line, VII, 31—3.

**Ellipsoid, Centro-Surface of, memoir:** VIII, 316—65; introductory, VIII, 316—7; the ellipsoid, VIII, 317—20; sequential and concomitant centro-curves, VIII, 320; expressions for coordinates of point on centro-surface, VIII, 320—4; discussion by means of equations, principal sections, &c., VIII, 324—30; generation of surface considered geometrically, VIII, 330—1; nodal curve, VIII, 332—52; eight cuspidal conics, VIII, 352—7; centro-surface as envelope of quadric, VIII, 357—8; another generation of centro-surface, VIII, 359—61; a third generation of centro-surface, VIII, 361—2; reciprocal surface, VIII, 363; delineation of centro-surface for particular case, VIII, 363—5.

**Ellipsoid, Geodesic Lines on, memoir:** VII, 493—510; introductory, VII, 493—4; course of the lines, VII, 494—5; lines through an umbilicus, VII, 495—501; formulæ, VII, 501—3; umbilicar geodesics, VII, 503; tables, VII, 504—6; projection on umbilicar plane, VII, 507; elliptic function formulæ, VII, 507—10; diagram, VII, to face 510.

**Ellipsoids:** lines of curvature, I, 36—9; surface parallel to, IV, 123—33, 158—65, x, 575; the momental, IV, 560; of gyration, IV, 560; central, IV, 564; projection, v, 487—8; geodesic lines on, VII, 34—5; centro-surface and sextic torse, VII, 113—4; centro-surface, VII, 130—2; geodesic lines, VIII, 174—8;

attraction of ellipsoidal shell on exterior point, IX, 302—11; negative pedals, x, 576; in *Ency. Brit.*, XI, 576—9.

**Elliptic Coordinates**: equation of wave surface in, XI, 71—2.

**Elliptic Functions**: Bronwin on, I, 118, 119; of Jacobi, I, 127, 507, 586; integral calculus, I, 383; multiplication of, I, 534—9, 568—76, 589; addition of, I, 540—9, 589, XII, 294—8; connected with theory of numbers, II, 48; system of modular symbols, IV, 484—9; Weierstrass, v, 33—7; treatise by Cayley, VIII, xviii, xxviii, XIII, 560; a general differential equation, IX, 592—608; a differential equation in theory of, x, 24; and integration, x, 25—7; torse depending on, x, 73—8; reduction of Abelian integrals to, x, 214—22; and single theta functions, x, 422—9, 463, 472; certain algebraic identities, XI, 130—1; evolution of, XI, 451—5; and quartic function, XI, 483; kinds of, XI, 529; symmetrical differential equation and, XII, 30—2; solution of  $x^3 + y^3 - 1 = 0$ , XII, 35—7; Weierstrassian and Jacobian compared, XII, 425—7; Kiepert's  $L$ -equations, XII, 490—2; graphical representation, XIII, 9—19; and sextic resolvent equations, XIII, 473—9; theta and omega functions, XIII, 558—9; (*see also* Gudermannian, Theta functions).

**Elliptic Functions Formulæ**: Serret's, III, 3; for geodesic lines on special ellipsoid, VII, 507—10; one, XI, 65, XII, 292—3; connexion of certain, XI, 250—1; geometrical interpretation of certain, XII, 107.

**Elliptic Functions, Inverse**: I, 136—55, 156—82, 586; and definite integrals, II, 3.

**Elliptic Functions, Memoir on Transformation of**: IX, 113—75; introductory, IX, 113—4; the general problem, IX, 114—7;  $\Omega k$  modular equations, IX, 117—8; equation-systems, IX, 119—20;  $\Omega k$  form, IX, 121—6; modular equation, IX, 126—37; tables, IX, 128—35, 163; multiplier equation, IX, 138—40; multiplier as rational function of  $u, v$ , IX, 140—4; multiplication of elliptic functions, IX, 144—7; transformations, IX, 147—55; general theory of  $q$ -transcendents, IX, 155—69; four forms of modular equation and curves represented thereby, IX, 169—75.

**Elliptic Functions, Theorems in**: XI, 73—7; Landen's, XI, 337—9, 584; Hermite's  $H$ -product, XII, 584—6.

**Elliptic Functions, Theory of**: I, 290—300, 364—5, 402—4, 587, 589; and quadri-quadric curve, XII, 321—5.

**Elliptic Functions, Transformation of**: I, 120—2, 132—5, 585, IX, 543, x, 333—8, 611, XI, 26, XII, 416—7, 505—34, 535—55, XIII, 29—32; cubic, III, 266—7, VII, 44—6, 244—5, 253—6, XII, 46, 556—7, XIII, 64—5; special quartic, IX, 103—6; geometric illustration of cubic, IX, 522—6; orthomorphosis, XIII, 191—205.

**Elliptic Integrals**: reduction of  $\frac{du}{\sqrt{U}}$ , I, 224—7; transformation, I, 508—10, IX, 618—21; geometrical representation, II, 53—6, 113—7; discussion, II, 93—5; and covariants, II, 189—92; transformation formulæ, IV, 60—9, 609; expression for second kind of, x, 25—7; note on theory, x, 139—42; some formulæ in, x, 143—8; of third kind, x, 489—92; problem, x, 614; theta functions, XI, 41—6; note on, XI, 64; reduction of an integral to, XI, 270—1; of third kind, formulæ, XI, 340—1.

**Elliptic Motion**: expansion of true anomaly, III, 139—42, 567; trilinear equation of second degree, III, 143—8; theory of, III, 216—8; tables of functions in theory, III, 360—474, VII, 516; Lambert's theorem, III, 562—5, VII, 387—9; and dynamical progress, IV, 521—4; a theorem, IX, 191—3; and body let fall at equator, IX, 241—3.

**Elliptic Motion, Disturbed**: memoirs on, III, 270—92, 344—59, 505—15.

**Elliptic Space**: and non-Euclidian geometry, XIII, 481.

**Elliptic-Transcendent Identity**: VIII, 564.

**Ellis, R. L.**: orthogonal surfaces, VIII, 272; differential equations, VIII, 458; Dupin's theorem, IX, 88.

**Emanants**: of quantics, II, 321; theory, II, 518; Bezoutoidal, II, 525, 526; the term, IV, 604, XIII, 46.

**Emanation**: theory of, II, 321.

**Encke, J. F.**: *über die speciellen Störungen*, III, 179—80; fluctuating functions, IX, 19; roots of numerical equations, x, 5.

## ENCYCLOPÆDIA—EQUATIONS.

96

*Encyclopædia Britannica*, articles from on:—Curve, XI, 460—89; Equation, XI, 490—521; Function, XI, 522—42; Galois, XI, 543; Gauss, XI, 544—5; Geometry (analytical), XI, 546—82; Landen, XI, 583—4; Locus, XI, 585; Monge, XI, 586—8; Partition of numbers, XI, 589—91; Theory of numbers, XI, 592—616; Series, XI, 617—27; Surface, XI, 628—39; John Wallis, XI, 640—3.

**Endecadic Transformation**: in elliptic functions, IX, 152—5.

**Endoscopic**: the term, I, 588.

**Ennead**: the term, VII, 256, VIII, 566.

**Enneadianome**: the term, VII, 134.

**Enneagon**: in-and-circumscribed, IV, 298—303.

**Envelopes**: developable of two equations, I, 486; parallel curves and surfaces, IV, 123—33, 152—7, 158—65; defined, IV, 458, VI, 467; of circle, V, 610, VII, 591; and locus in regard to triangle, VI, 72—82; depending on two circles, problem and solution, VII, 573; of plane curve, VII, 606; of a certain quadric surface, VIII, 48—50; locus in singular solutions, VIII, 533; problem of, VIII, 491—2; of family of quadrics, X, 589; theory, XI, 50—1; of variable curves, XI, 475—6.

**Epicycloid**: and caustic, II, 345.

**Epispheric integrals**: Gauss-Jacobi theory, IX, 410—7.

**Epitrochoid**: XIII, 81—7.

**Equal**: applied to circles, VIII, 31.

**Equality**: among roots of an equation, II, 465—70, VI, 300—12; idea of, XI, 431.

**Equation of Differences**: for equation of any degree, IV, 150—1; for equation of any order, IV, 240—61; tables, IV, 246—56; of all but one, of roots of given equation, IV, 276—91; and quintic equation, IV, 309—24, 609—16; and cubic equation, IV, 463—5.

**Equation, Pellian** (*see* Pellian Equation).

**Equations**: systems of spherical coordinates, I, 213—23; with quantics, defined, II, 221; auxiliary for quintics, IV, 309—24; determination of reciprocal, with cubic surfaces, VI, 368—70; the term, VI, 466; solubility by radicals, VII, 13—4; system of, problem and solution, VII, 578, 581, X, 601; transformation, IX, 42, 48—51; on a functional equation, X, 298—306; Cassinian, problem, X, 608; Jacobian sextic, XI, 389—401, XII, 493—9; equal roots of, XI, 405—7; of curves, XI, 462—4; of Plücker, XI, 469—73, XIII, 536; in *Ency. Brit.*, XI, 490—521, (introductory, XI, 490; determinant, XI, 490—7; imaginary, XI, 502—6); of right line and circle, XI, 558—61; of conics, XI, 563; seminvariants, XII, 19—21; fundamental, and deformation of surfaces, XI, 331; note on system of, XII, 48—9; for three circles which cut each other at given angles, XII, 559—61, 564—70; anharmonic ratio, XII, 578—9; hydrodynamical, XIII, 6—8; Sylvester on ternary cubic-form, XIII, 47; on soluble quintic, XIII, 88—92; Waring's formula for sum of  $m$ th powers of roots of, XIII, 213—6; sextic resolvent of Jacobi and Kronecker, XIII, 473—9.

**Equations, Algebraic**: rationalization, II, 40—4; theory, II, 124; theorem that every one has a root, IV, 116—9; system of, IV, 171—2, VIII, 29—30; in *Ency. Brit.*, XI, 506—21; Anglin's formula for successive powers of the root of, XII, 33—4; roots of one, XIII, 33—7.

**Equations, Cubic** (*see* Cubic equations).

**Equations, Modular**: for transformation of order 11, XIII, 38—40; for cubic transformation, XIII, 64—5; (*see also* Transformation of Elliptic Functions).

**Equations of Motion**: in lunar theory, XIII, 206.

**Equations, Solutions of**:  $x^{257}-1=0$ , I, 564—6;  $\theta^n=1$ , and theory of groups, II, 123—30, 131—2, IV, 88—91, X, 610;  $x^p-1=0$ , XI, 314—6, XII, 72—3; elliptic function solution of  $x^3+y^3-1=0$ , XII, 35—7; the quaternion  $qQ-Qq'=0$ , XII, 300—4, 311—3;  $(abcd)=(a^2b^2c^2d^2)$ , XII, 418—20;  $x^{17}-1=0$ , XIII, 60—3.

**Equations, Theory of**: synopsis, X, 3—11; Newton-Fourier method, and imaginary root, XI, 114—21, 143; theorem of Abel's and quintic equation, XI, 132—5; theorem in, XI, 268—9; evolution, XI, 455; in *Ency. Brit.*, XI, 497—521.

- Equator**: action of gravity at the, IX, 241—3.
- Equilibrium**: of four forces, V, 540—1, IX, 201; of skew surface, XI, 317—22.
- Equipomental Surfaces** (*see* Surfaces).
- Equipollences**: Bellavitis, XII, 473—4.
- Equipollent**: the term, XII, 473.
- Equipotential Curve**: III, 258—61.
- Essential Singularity of Function**: IV, 150.
- Eta-Functions**: product, XII, 584—6; (*see also* Theta Functions).
- Euclid**: space of, XI, 434—7; evolution of geometry, XI, 446; proof of I, 47, XI, 557.
- Euler, L.**: rotation of solid body, I, 237, IV, 566, 567—9, 587, VI, 135—46; involution, I, 259; elliptic functions, I, 366; skew determinants, II, 214; transformation of coordinates, II, 497, IV, 553—7, 587; sums of series, III, 127; indeterminate equations, III, 205—7; polyhedra, IV, 84, 86—7, V, 62—5, 617; *Determinatio Orbitæ Cometæ*, IV, 519, 587; problem of two centres, IV, 525—7, 587; three mutually attracting bodies in right line, IV, 538—9, 587; motion of three bodies, IV, 540, 587; inertia, IV, 562; kinematics of solid body, IV, 580, 587; rotation formulæ, V, 537; differential equation of, VII, 261—2, IX, 592—608, XI, 68—9; binomial theorem, VIII, 463; mathematical tables, IX, 463—6, 471—2, 477—8, 481, 487; theorem on sums of squares, XI, 294; partitions, XI, 360, XII, 219; intersections of cubic curves, XI, 449; gamma function, XI, 535—6; eight-squares theorem, XII, 465; Latin squares, XIII, 55; differential equation of, integrated by Richelot, XIII, 525—9.
- Evans, A. B.**: Degen's tables, X, 586.
- Evectant**: of quantics, II, 321.
- Evector**: of quantics, II, 321.
- Evolute**: theory of, V, 473—9; and parallel curves, VIII, 31—45; nodes of, VIII, 329, 351.
- Evolution**: of geometry, XI, 445—8.
- Ewing, J. A.**: curve-tracing mechanism, XIII, 505.
- Excuboquartic**: defined, V, 10, VII, 99; curves, VI, 87—8, XI, 9—13.
- Exoscopic**: the term, I, 588.
- Expansions**: in multiple sines and cosines, I, 19—24, 583; in Laplace's coefficients, I, 375—6; of true anomaly, III, 139—42; numerical, IV, 470—2.
- Expectation**: problem and solution in, X, 587; (*see also* Probability).
- Experience and Cognition**: XI, 431.
- Exponential Functions**: and double theta functions, X, 184—5; the term, XI, 524—7.
- Extension**: in conformal representation, XI, 78.
- Extent**: the term in seminvariants, XIII, 269, 363.
- Extraordinaries**: and non-commutative algebras, I, 128—31, 301; the term, XII, 60, 461.
- Facients**: defined, II, 221, IV, 604, VI, 464.
- Factions**: the term, IX, 426.
- Factorial Expressions**: summation of, III, 250—3.
- Factorials**: developments of, II, 98—101, 594; problems, V, 574, VII, 597; binomial theorem and derivations, VIII, 463—73; maxima of certain functions, VIII, 548—9.
- Factors, Special**: the term, I, 337.
- Facultative**: the term, VI, 156, 365; lines of cubic surfaces, VI, 450.
- Facultative Points**: of Sylvester, XIII, 46.
- Family of Quadrics**: envelope of, X, 589.
- Family of Surfaces**: part of orthogonal system, VIII, 269—91.
- Fermat, P. de**: theorem of, XI, 457, 597, 611, 615—6.
- Ferrers, N. M.**: conjugate partitions, II, 419; area of conic, III, 143—8; correspondence, X, 290; Legendrian coefficients, XII, 563.
- C. XIV.

**FIEDLER—FRESNEL.**

98

**Fiedler, W.:** symmetric functions, II, 602.**Figures:** for Pascal's theorem, VI, 116—23; mechanical construction of conformable, X, 406; use of arabic, XI, 446.**Finite Differences:** formulæ in, III, 132—5, XII, 412—5; electricity on spherical surfaces, IV, 92—8, 99—107; theorem and demonstration, IV, 262—4; general equation of differences of second order, X, 47—9; Stirling's theorem, X, 267—8; table of, XI, 144—7.**Finite Groups** (*see* Groups).**Finiteness:** of concomitant system of quantic, VII, 334, XI, 272—80.**First Kind:** of Abelian integrals, XII, 408—11.**First Order:** of differential equations, XII, 432—41; (*see also* Differential Equations).**Five-dimensional Geometry:** IX, 79; (*see also* Hypergeometry).**Five-pointic Contact:** conic of, IV, 207—39.**Flat:** the term in covariants, VIII, 406—8.**Flat-cone:** the term, VIII, 102.**Flecnodal Curve:** VI, 342; and torse, VI, 345, 582—5.**Flecnode:** defined, II, 28—32.**Flefnodal Planes:** of a surface, X, 262—4.**Flefnode:** defined, II, 28—32, IX, 264; of curve in transformation of elliptic functions, IX, 170—1.**Flex:** the term, V, 521.**Flexure of Skew Surface:** XI, 317—22; (*see also* Surfaces).**Floquet, G.:** linear differential equations, XII, 394, 402.**Fluctuating Functions:** addition to Lord Rayleigh's paper, IX, 19—20.**Fluxions:** and Landen, XI, 583.**Focals:** of a quadric surface, XIII, 51—4.**Foci:** of conics, IV, 505—9, VII, 1—4, 571; theory of, VI, 515—34; and antifoci, problem and solution, VII, 567; locus of, problem and solution, VII, 568.**Focus:** the term, VI, 515, IX, 552, XI, 481.**Foot:** non-Euclidian geometry, XIII, 483—4.**Forcenex, D. de:** multiple algebra, XII, 466.**Forces:** equilibrium of, V, 540—1, VII, 91—5; general equation of virtual velocities, IX, 205—8; resultant, X, 589; (*see also* Dynamics).**Forms:** cubic, III, 9—12; quadratic, III, 11—12; theory, XI, 604—9.**Formulæ:** Jacobi's canonical, for disturbed motion, III, 76—7; in finite differences, III, 132—5; for differentiation, IV, 135—49; distances of point, and tactions, IV, 510—2; signification of elementary one in solid geometry, V, 498—9; integrals for intersections of line and conic, V, 500—4; canonical form of quantics, VI, 153—4; of two sets each of four concyclic points, VI, 509—11, 512—5; focal, and polyzomal curves, VI, 547, 549; of de Jonquières, VII, 41—3; transformation of coordinates, VII, 95—6, 97—8; geodesic lines on ellipsoid, VII, 501—3, 507—10; trigonometric, XII, 108.**Forsyth, A. R.:** biographical notice of Cayley, VIII, ix—xliv; addition of elliptic functions, XII, 294.**Foucault, J. B. L.:** the earth's rotation, IV, 535, 536, 588.**Fouché, M.:** polyhedra, IV, 609.**Fourier, J. B. J.:** theorem as to roots of equations, X, 5; theory of equations, XI, 500; (*see also* Newton-Fourier Theorem).**Fourth Dimension:** Cayley on, VIII, xxxiii—v.**Fraction-Theorem:** Jacobi's, XII, 123—5.**Francais, J. F.:** imaginaries, XII, 468.**Franklin, F.:** quantics, XIII, 47.**Fresnel, A. J.:** wave-surface, IV, 420, XI, 449; wave and tetrahedroid surfaces, X, 252; Sylvester on the optical theory of, XIII, 44.



- Frobenius, G.:** linear differential equations, XII, 394.
- Frost, P.:** curves of curvature near umbilicus, VII, 330—1.
- Fuchs, L.:** Schwarzian derivative and polyhedral functions, XI, 149; linear differential equations, XII, 394, 453.
- Function:** the term “derivational,” I, 63; transformation of bipartite quadric, II, 497—505; relation among derivatives of, X, 590—2; octahedron, XI, 128—9; general theory of, XI, 439—41; linear, XI, 492; in *Ency. Brit.*, XI, 522—42, (introductory, XI, 522—3; known functions, XI, 523—37; functions in general, XI, 537—41; calculus of, XI, 541—2); two invariants of quadri-quadric, XIII, 67—8; on the modular  $\chi\omega$ , XIII, 338—41.
- Functional Determinant:** the term, II, 319, IV, 607.
- Functional Equation:** theorem of Abel, IV, 5—6.
- Functions:** doubly-periodic, II, 150—63; notation of algebraic, II, 185—8;  $\text{al}(x)$  of Weierstrass, V, 33—7; homotypical, V, 50; rhizic, IX, 34; tests for dependence of, X, 97; early history of theory, XI, 451—5; values of symmetric, XIII, 318—21; on lacunary, XIII, 415—7; (*see also* Schwarzian Derivative, Generating Functions, Symmetric Functions).
- Fundamental Notions:** in Mathematics, XI, 434—8, 442—5.
- Fuss, P. H. v.:** porism formula, II, 90; in-and-circumscribed polygon, II, 140, V, 21—2.
- Galileo:** and dynamics, XI, 447.
- Galois, E.:** groups and permutations, II, 134; groups, XI, 133, XIII, 533; theory of numbers, XI, 457, 593, 614; theory of equations, XI, 518—9, 520, 521; biographical notice, XI, 543.
- Gamma Function:** theory, I, 309—16, 588; a double infinite series, II, 8; the term, XI, 534; (*see also* Definite Integrals).
- Gaultier, L.:** systems of circles, III, 113; radical axis, XI, 465.
- Gauss, J. K. F.:** determinants, I, 64; linear transformations, I, 585; attraction of ellipsoids, III, 25—8, 149—53; central forces problem, IV, 520, 588; relative motion, IV, 534; binary quadratic forms, V, 618; *pentagramma mirificum*, VII, 37—8; *Theoria Motus*, VII, 414; geodesic lines on quadric surface, VIII, 156—61; potential of ellipse, IX, 281—2; epispheric integrals, IX, 321, 410—17; mathematical tables, IX, 466—7, 470, 472, 475—7, 488; roots of unity, XI, 60; lemniscate, XI, 64; calculation of  $\log 2$ , XI, 70; geodesic curvature, XI, 323—4; his theory of surfaces, XI, 331—6; imaginary variables, XI, 439; attractions, XI, 448; theory of equations, XI, 455, 504, 516; theory of numbers, XI, 455, 599, 603; gamma function, XI, 534; biographical notice, XI, 544—5; multiple algebra, XII, 471—2; roots of algebraic equation, XIII, 35; orthomorphosis, XIII, 191; application of surfaces to each other, XIII, 253—64.
- Geiser, C. F.:** quartic and quintic surfaces, VII, 252; theorem of Cotterill, IX, 506.
- Generating Functions:** of symmetric functions, Borchardt's, II, 417, 421—3; connected with covariants, IX, 537—42; of quintic, X, 339—400; of quartic, X, 341; of sextic, and binary sextic, X, 394—400; of binary septic, X, 408—21; seminvariants of a given degree, XIII, 306—8.
- Generation:** of bicircular quartic, X, 223—6.
- Generator:** the term, V, 169—70, 173—9, 181; nodal, of scrolls, V, 169—70, 179—81.
- Generatrix:** and the absolute, XIII, 481—9, 501.
- Genese, R. W.:** theory of envelopes, XI, 50—1.
- Genus of Curve:** (Geschlecht), after Riemann, V, 467, 517, 619.
- Geodesic Curvature:** XI, 323—30.
- Geodesic Lines:** property of, III, 38; on oblate spheroid, VII, 15—25; on ellipsoid, VII, 34—5; in *Ency. Brit.*, XI, 628, 636—7; of pseudosphere, XII, 220—38; wave surfaces, XIII, 252; (*see also* Ellipsoids).
- Geodesic Lines, in particular on quadric surface, memoir:** VIII, 156—78, 188—99; preliminary formulæ, VIII, 156—8; general theory of them on a surface, VIII, 159—62; circular curves are geodesics, VIII, 162; chief lines not in general geodesics, VIII, 163; special form of geodesic equation, VIII, 163—4;

**GEOMETRICAL—GORDAN.**

100

geodesics on quadric surface, VIII, 164—70; formulæ for position of point, VIII, 170—4; ellipsoid and skew hyperboloid, VIII, 174—8, 188—99; tables, VIII, 196—9.

**Geometrical Construction**: in optics, x, 28; of heptagon, x, 609.

**Geometrical Representation**: of elliptic functions, III, 3; of imaginary variables, x, 316—23; of an equation between two variables, XII, 104.

**Geometry**: of  $n$  dimensions, I, 55—62; reciprocity, I, 377—82; of quantics, II, 222; of one and two dimensions defined, II, 561—2; of one dimension, II, 563—9, 583—96; of two dimensions, II, 569—83, 586—92; relations of, metrical and descriptive, II, 592; non-Euclidian and hyper-, II, 604—6, VIII, xxxiii—v, 409—13, XII, 220—38; Lobatschewsky's imaginary, v, 471; problem of permutation, v, 493—4; signification of elementary formula, v, 498—9; notion of absolute, v, 550; drawings in, VI, 9; constructive, VII, 26—30; transformation, VII, 121—2; Cayley and Klein on metrical, VIII, xxxvi—vii; hyperbolic, elliptic and parabolic, VIII, xxxvii; Cayley's work in analytical, VIII, xxxviii; formulæ relating to right line, x, 287—9; considerations on solar eclipse, x, 310—5; interpretation of algebraic equations, x, 581; solid, XI, 224; Schubert's numerative, XI, 281—93; Mill on, XI, 432—4; Euclidian, XI, 434—7; Cartesian, XI, 437—9; abstract, XI, 441—2; origin, XI, 445—8; in Greece, XI, 446; evolution of descriptive, XI, 448—9; date of extensions in, XI, 449—51; plane and solid, XI, 450—1; function in, XI, 522—3; interpretation of elliptic function formulæ, XII, 107; d'Alembert Carnot paradox, XII, 305—6; of the compass, XII, 314—7; algebra and logic, XII, 459; (*see also* Hypergeometry: for General Theory, *see* Quantics, sixth memoir).

**Geometry, Abstract, Memoir on**: VI, 456—69, 596; introductory, VI, 456—7; space, VI, 456—7; general explanations, VI, 457—62, 596; omal relation, order, VI, 463; parametric relations, VI, 463—4; quantics, notations, etc., VI, 464—6; resultant, discriminant, VI, 466—7; consecutive points, tangent omals, VI, 467—9.

**Geometry, Analytical, in Ency. Brit.**: XI, 546—82; introductory, XI, 546; Part I, pure analytical, XI, 546—67; is descriptive, XI, 552—6; metrical theory, XI, 556—7; equations of right line and circle—transformation of coordinates, XI, 558—61; the conics, XI, 561—4; tangent, normal, circle and radius of curvature, XI, 564—5; coordinates, XI, 566—7; Part II, solid analytical geometry, introductory, XI, 567—9; metrical theory, XI, 570; line, plane, and sphere, XI, 571—2; cylinders, cones, ruled surfaces, XI, 572—3; transformation of coordinates, XI, 573—6; quadric surfaces (paraboloids, ellipsoids, and hyperboloids), XI, 576—9; curves: tangent, osculating plane, curvature, XI, 579—80; surfaces: tangent lines and plane, curvature, XI, 580—2; (*see also* Hypergeometry).

**Geometry of Position**: theorems in, I, 317—28, 356—61, 414—20, 550—6, 567, 588.

**Gergonne, J. D.**: caustics, II, 118, 339, 341, 368; polyzomal curves, VI, 520.

**Geschlecht**: (genus) of curve, after Riemann, v, 467, 517, 619.

**Glaisher, J. W. L.**: notation for elliptic functions, I, 548; definite integration, VIII, 1; centro-surface of ellipsoid, VIII, 364; report on mathematical tables, IX, 461—99; development of an idea of Eisenstein, x, 58—9; proof of Stirling's theorem, x, 267—8; quadrilateral inscribable in circle, x, 578; log 2, XI, 70; elliptic functions, XI, 73; least factors of numbers, XI, 430; modular function  $\chi\omega$ , XIII, 338—41; theta and omega functions, XIII, 558—9.

**Glide**: the term, I, 236.

**Glover, J. W.**: on theory of groups, XIII, 533.

**Goniometry**: Cotterill's problem in, x, 295—7.

**Göpel, A.**: theory of numbers, IV, 41; theta functions, VIII, xlii, x, 464, 499, XII, 363—4; double theta functions and 16-nodal quartic surface, x, 157, 162, 172, 173, 175, 180—1; table of tetrads, 508, 549—51; double theta functions, XI, 454.

**Gordan, P.**: binary quintic and sextic, VI, 190; irreducible covariants of binary quantic, VII, 334, 341, 348—53; covariants of binary quantic, VIII, 566; finiteness of concomitant systems, x, 286; derivatives, x, 340, 377; Schwarzian derivative and polyhedral functions, XI, 149, 199; finite groups, XI, 237—41; covariantive forms and tables, XI, 272; concomitants of ternary cubic, XI, 343; Abelian functions, XII, 102, 109; icosahedral substitutions, XIII, 552.

- Goursat, E.:** Kummer's differential equation, XIII, 69—73.
- Graduation Curve:** the term, VII, 426.
- Graham, A.:** Pellian equation, XIII, 442.
- Grant, R.:** report on Catalogue of Memoirs, v, 546—8, 620.
- Graphical Construction:** in solar eclipses, VII, 390—1, 479—92; geodesic lines on ellipsoid, VII, 507, 510; theory of groups, x, 403—5.
- Grassmann, H.:** multiple algebra, XII, 465, 480—9.
- Gravelius, H.:** on non-Euclidian geometry, XIII, 481.
- Graves, J. T.:** algebraic couples, I, 128; geometry of position, I, 319, 414—20; imaginaries, I, 586.
- Gravity:** and relative motion, IV, 534—7; action at equator, IX, 241—3; Clairaut's theorem, x, 17—8; effects of theory, XI, 447—8.
- Greatheed, S. S.:** expansions in multiple sines, I, 583; elliptic motion, IV, 522, 588.
- Greek:** Cayley's knowledge of, VIII, xxiv; geometry, arithmetic, and algebra, XI, 446.
- Green, G.:** attractions of ellipsoids, I, 582; attraction of terminated straight line, VII, 32; potentials of polygons and polyhedra, IX, 279; integration of prepotential equation, IX, 320—1, 343, 393—404; attractions, XI, 448.
- Greenhill, A. G.:** deformation and flexure of surfaces, XI, 66—7.
- Greenians:** the term, IX, 393.
- Greer, H. R.:** locus, envelope, and triangle, VI, 72.
- Gregory, D. F.:** differential and integral calculus, VIII, 272.
- Griffiths, J.:** series of triangles, VII, 599; curve of sixth order, x, 612; deduction from  $y = \sin(A + B + C + \dots)$ , XII, 58—9.
- Ground-curve:** and Abel's theorem, XII, 38, 109—216.
- Groups:** of lines and points, I, 317—28, 356—61, 414—20, 550—6; depending on symbolic equation  $\theta^n = 1$ , II, 123—30, 131—2, IV, 88—91; theory of, IV, 88—91, x, 324—30, XII, 639—56; the term, IV, 594, 596, VII, 123; rotations of polyhedra, v, 529, 559; Cayley's work at, VIII, xxxiii; theorems on, x, 149—52, 153—4; desiderata and suggestions on theory, x, 401—6; partitions and theory of, XI, 62; homographic transformations, XI, 189—90, 196—208, 237—41; linear transformation of a variable, XI, 237—41; Jacobian sextic, XI, 389, 393—6; the notion, XI, 509—10; Latin squares, XIII, 55—7; substitution groups for two to eight letters, XIII, 117—49; of points, non-existence of a special, XIII, 212; quotient  $G/H$  in theory of, XIII, 336—7; illustrations of Sylow's theorems on, XIII, 530—3; of sixty icosahedral substitutions, XIII, 552, 556.
- Grunert, J. A.:** difference-table, XI, 144.
- Gudermann, C.:** elliptic integrals, I, 224; transformation of an integral, I, 383; transformation of elliptic functions, III, 2; spherical pendulum, IV, 534, 588; logarithms, VII, 414.
- Gudermannian:** v, 86—8, 617; Lobatschewsky's imaginary geometry, v, 472; tables of, v, 617.
- Gundelfinger, S.:** concomitants of ternary cubic, XI, 342—3.
- Hall, A.:** motion of particle towards attracting centre, IX, 215—7.
- Halphen, G. H.:** inverse elliptic functions, I, 586; curves in space, v, 613—7; higher singularities of plane curves, v, 619; curves satisfying given conditions, VI, 594—5; classification of curves, XI, 451; invariants of differential equations, XII, 392—3; transformation in elliptic functions, XIII, 29; Sylvester on reciprocants, XIII, 48; reciprocants, XIII, 333, 366, 368—81, 381—98; characteristic  $n$  in the theory of curves in space, XIII, 468—72.
- Halsted, G. B.:** hyperspace and non-Euclidian geometry, II, 606.
- Hamilton, Sir W. R.:** quaternions, I, 123—6, 238, 335, 586; form of equations of motion, I, 284; homographic transformation of quadrics, II, 105, 133; focal relations, II, 143; problem of three or more bodies, III, 97—103; differential equations, III, 164, IV, 514; method of dynamics, III, 166—74, 200, 202; equations of motion, III, 186; isochronism of circular hodograph, III, 262—5;

**HAMMOND—HERSCHEL.**

102

essential singularity of function, IV, 105; central forces problem, IV, 520; hodograph, IV, 520; transformation of coordinates, IV, 558—9, 588; ray systems, VIII, 504, XII, 571—5; surface orthogonal to set of lines, IX, 587; system of differential equations, X, 113—8; equations of central orbit, X, 613; on mathematics, XI, 431; algebra and time, XI, 443; conical refraction, XI, 449; multiple algebra, XII, 460, 466, 474—5; Sylvester on Hamiltonian numbers, XIII, 48; (*see also* Differential Equations).

**Hammond, J.:** theory of tamsage, XI, 409—10; seminvariants, XII, 253; Sylvester's reciprocants, XIII, 47—8, 381, 388; on Hamiltonian numbers, XIII, 48.

**Hansen, P. A.:** lunar theory, III, 13—24, 291—2; elliptic orbit, III, 95; expansion of true anomaly, III, 140; planetary theory, III, 268—9, IX, 180—3; disturbed elliptic motion, III, 270—1; disturbing function in lunar theory, III, 293, 319—43; variation of plane of planet's orbit, III, 516—8; elliptic motion, IV, 522, 523, 588; relative motion, IV, 536, 588; pendulum, IV, 541, 588; spheroidal trigonometry, IX, 197.

**Hargreave, C. J.:** on differential equations, VIII, 458.

**Harley, R.:** equation of differences, IV, 241, 245; symmetric products and quintics, IV, 310—13; quintics, V, 53; a differential equation, VII, 354; theory of equations, XI, 520; invariants, XII, 390—1.

**Harmoconic:** defined, V, 342.

**Harmonic Relations:** of two lines or points, II, 96—7; theory of, and two or more quadrics, II, 529—40.

**Harmonics:** symmetric, II, 555; inscribed, III, 113; reciprocal lines, XIII, 58—9; and non-Euclidian geometry, XIII, 482—9.

**Harriot, T.:** mathematical discoveries, XI, 437.

**Hart, A. S.:** cubic curves, IV, 499; relative motion, IV, 535; triple tangent planes, VI, 372, 375; nine-point circle, XIII, 548.

**Haughton, S.:** inertia, IV, 564—5, 588.

**Haupttangenten:** (inflexional tangents), VIII, 157.

**Heal, W. E.:** bitangents of quintic, XIII, 21.

**Hearn, G. W.:** on a geometrical locus, I, 496; quartic curves, I, 496; quadric curves, V, 262.

**Heath, R. S.:** non-Euclidian geometry, XIII, 481, 499.

**Helmholtz, H. von:** hydrodynamical equations, XIII, 6—8.

**Hemihedron:** the word, X, 328.

**Hemipolyhedron:** the word, X, 328.

**Hensley, P. J.:** foci of conics, IV, 505—9.

**Heptacron** (*see* Polyacra).

**Heptagon:** construction, X, 609.

**Hermite, C.:** homographic transformation of quadric into itself, II, 107; elliptic integral and covariants of quartic, II, 191; law of reciprocity, II, 232, 234; skew invariant of quintic, II, 233; transformation of quadric function, II, 499; hyperdeterminants, II, 598—601; elliptic integrals, IV, 68—9; ternary cubics, IV, 326, 330; Tschirnhausen's transformation, IV, 364—7, 375, VI, 165, 170; automorphic transformation, IV, 416; elliptic functions and solution of quintic, IV, 484—9; matrices, V, 438, XII, 367—70, 386; quantics, VI, 147; quintic equation, VI, 170; nodal cubic, VI, 174—6; canonical form of quintic, VI, 177—83; transformation of elliptic functions, VII, 44, IX, 113, XII, 337, 416—7, XIII, 31, 39; reduction of Abelian integrals, X, 214; concomitants of ternary cubic, XI, 342; elliptic functions, XI, 452; theory of equations, XI, 520; Abelian functions, XII, 98; transformation of double theta functions, XII, 358; *H*-product theorem, XII, 584—6; cubic equations, XIII, 349; omega functions, XIII, 558.

**Herschel, Sir J. F. W.:** finite differences, IV, 95, 107, 262; Brinkley's formulæ, X, 58—9; difference table, XI, 144.

- Hesse, L. O.:** linear transformations, I, 87, 113—6, 232—3, 584, 585, VI, 22—3, 73; cubic curves, I, 194, II, 399; involution, I, 259; hyperdeterminants, I, 354; abstract of memoir on quadric surfaces, I, 425—7; inflexions of cubic, I, 584, II, 29, III, 48; on elimination, IV, 3; on inflexions, IV, 186, XI, 473; double tangents, IV, 186—7, 343—6; cubic forms, IV, 353; geometric transformation, VII, 121—2; bitangents of quartic curve, VII, 123—4; double theta functions, X, 177; triple theta functions, X, 446, 448, 451; the thirty-four concomitants of ternary cubic, XI, 342; bitangents of a plane quartic, XII, 76.
- Hessians:** and Eisenstein's theorem, I, 585; defined, II, 319, IV, 607, XI, 471, 474; and Pippian, II, 381—2, 383—95, 416; the sign for, II, 541; the quadricovariant, II, 545; of quaternary functions, IX, 90—3; of a quartic surface, X, 274—7; (*see also* Quantics).
- Hexagon:** and conic, problem, V, 576; theorem of inscribed, XI, 556.
- Hexagram** (*see* Pascal's theorem).
- Hexahedron:** edges of, problem, X, 613; automorphic function for, XI, 184.
- Hierholzer, C.:** cones satisfying six conditions, VIII, 99; surface of eighth order, VIII, 401.
- Higher Singularities of Curves** (*see* Singularities).
- Hilbert, D.:** curves in space, V, 614; abstract geometry, VI, 596.
- Hills:** altitude, and roots of algebraic equation, XIII, 33—7.
- Hirsch, Meyer:** algebra of, II, 417, 440; partitions, VII, 577.
- Hirst, T. A.:** negative pedals, IV, 164.
- History:** importance of mathematical, VIII, xii.
- Hodograph:** isochronism of circular, III, 262—5; Hamilton's, IV, 520; and pedal curves, V, 113.
- Hölder, O.:** theory of groups, XIII, 336, 533.
- Holditch, H.:** caustics, II, 363.
- Holomorphic:** the term, XI, 81.
- Homaloids:** prepotentials of, IX, 408—9.
- Homographic Figures:** matrices, II, 219; theorem, IV, 442—5.
- Homographic Function:** distribution of electricity, XI, 2—6; and matrix of the second order, XI, 252—7.
- Homographic Relations:** and theory of numbers, IX, 613; function of, X, 298—306; powers of, X, 305—6, 307—9.
- Homographic Transformation:** of quadric surfaces, II, 105—112; of single theta functions, XII, 337—43; (*see also* Groups, Transformations).
- Homographies:** correspondence with rotations, X, 153—4, XI, 237—8.
- Homography:** different classes of, II, 219—220; and quadrics, II, 536—40; ternary quantics and theory of, II, 565—9, 578; of ranges and pencils, II, 578.
- Homology:** of conics, I, 523, 557; the term, I, 557—8; of sets, III, 35.
- Homotypic:** the term, VII, 123.
- Homotypical:** the term, V, 50.
- Hopkins, W.:** attractions and multiple integrals, I, 582.
- Horner, W. G.:** theory of equations, XI, 499, 502.
- Hoüel, J.:** equations of motion, III, 169, 170.
- Hudson, C.:** equal roots of equations, XI, 405—7.
- Hydrodynamics:** note on equations of, XIII, 6—8.
- Hydrogen:** trees of, IX, 427—60, 544—5.
- Hyperbola:** rectangular, III, 254, V, 554; classification, V, 354—400, VIII, xxxviii; arc of, XI, 337—9; and cubic curves, XI, 478; in *Ency. Brit.*, XI, 561—4; focals of quadric surface, XIII, 54; and epitrochoid, XIII, 82—7; tactions, XIII, 150—69; (*see also* Conics).
- Hyperboloid:** coordinates of, V, 72; and scrolls, VII, 65; and tractor, VII, 73—5; passing through three given lines, VII, 86—8; Mercator's projection, VIII, 568, IX, 237—40; deformation, XI, 66—7; in *Ency. Brit.*, XI, 576—9; confocal Cartesians and right lines of, XII, 587—9.

**HYPERDETERMINANTS—INTEGRAL.**

104

- Hyperdeterminants**: the term, I, 81, 95, 114, 585; note on, I, 352—5, 588; a system of certain formulæ, I, 533; theory, I, 577—9; theory of permutants, II, 19; theory of intermutants, II, 26; quantics, II, 225; theory of seminvariants, XII, 344; Sylvester's work in, XIII, 46; an identity, XIII, 210—11; (*see also* Covariants, Invariants).
- Hyperdimensional Space**: quadrics in, IX, 79—83; (*see also* Hypergeometry, Hyperspace).
- Hyperelliptic Functions**: trisection of, VI, 594; and theta functions, X, 162—5, 166—79, 184—214, 551—5; and triple theta functions, X, 432—6; addition-theorem, X, 455—62; the term, XI, 533—4; and nodal quartics, XII, 196—208; (*see also* Theta-Functions).
- Hyperelliptic Integrals**: of first order, XII, 98—9.
- Hypergeometric Series**: summation of a certain factorial expression, III, 250—3; theorem, III, 268—9; differential equations, XI, 17—25; note on, XI, 125—7; and Schwarzian derivative, XI, 176—9.
- Hypergeometry**: of  $n$  dimensions, I, 55—62; a branch of mathematics, VIII, xxxiii—v; five-dimensional, IX, 79—83; and quadric surfaces, IX, 246—9; 21 coordinates of conic in space, XI, 82—3; Sylvester's work in, XIII, 46; (*see also* Hyperspace, Prepotentials).
- Hyperspace**: and quantics, II, 222; and non-Euclidian geometry, II, 606; representation by means of, VI, 198; of four dimensions, special theorem, IX, 246—9; (*see also* Hypergeometry).
- Icosahedra**: construction, IV, 81—2; axial systems, V, 531—9; Klein on rotations of, X, 153; as regular solids, X, 270—3; automorphic function, XI, 169, 179—83, 185, 212—6.
- Icosahedral Substitutions** (*see* Substitutions).
- Ideal**: the term, VI, 483.
- Ideal Numbers**: XI, 456.
- Idem**: defined, XII, 66.
- Idempotent**: the term, XII, 61.
- Identities**: cubic, V, 597; trigonometrical, VIII, 525, XI, 38, XIII, 538—40; elliptic transcendent, VIII, 564; a transcendental, XI, 37; algebraic, XI, 63—4, 130—1, XIII, 76—8; a hyperdeterminant, XIII, 210—11.
- Imaginariness**: on an octuple system of, I, 301; eight-square, XI, 368—71, XII, 465; the term, XI, 439; theory of equations, XI, 502—6; and function, XI, 523; associative, XII, 61, 105—6; perpendicularity, XII, 466—72; roots of equation, XIII, 36; Sylvester's work at, XIII, 46; quaternions, XIII, 542.
- Imaginary Quantities**: logarithms, VI, 14—8; geometrical construction relating to, XI, 258—60.
- Immit**: defined, IV, 109.
- Improper**: conditions for curves, VI, 193.
- Increment**: the term, VI, 468.
- Indefinite**: applied to integration, IX, 500—3; the term, XIII, 290.
- Indeterminate Equations**: problem in indeterminate analysis, III, 205—7.
- Index**: to philosophic memoirs, report on, V, 546—8, 620.
- Indicial Equation**: of differential equation, XII, 398, 453.
- Indicial Function**: of differential equation, XII, 398, 401.
- Inertia**: axes and moments of, IV, 478—80, 559—66.
- Ineunt**: defined, II, 574, V, 521, VI, 469; non-Euclidian geometry, XIII, 489.
- Infinitesimal Rotations**: VI, 24—6.
- Infinity**: in geometry, XI, 464.
- Inflexional Tangents**: and geodesic lines, VIII, 157; (*see also* Tangents).
- Inflexions**: of cubical divergent parabolas, V, 284—8; of cubic curve, I, 584, III, 48; Hesse on, IV, 186, V, 493—4, XI, 473; of curves, XI, 471—3, 480.
- Integral Calculus**: some formulæ of, I, 309—16, 588; transformation, I, 383; Picard's memoir on, XII, 408—11.
- Integral Functions**: Legendre's coefficients, I, 375—6; the term, IV, 603—4, XI, 523; prepotential surface, IX, 321—30, 330—4, 352—9; potential solid, IX, 334—7; epispheric, IX, 410—17; reduction

of transcendental, x, 214—22; hyperelliptic, of first order, XII, 98—9; regular, of differential equation, XII, 395—6; number of, XII, 399; subregular of differential equation, XII, 444—52; (*see also* Abelian Integrals, Definite Integrals, Elliptic Integrals, Transformations).

**Integrals:** transformation of double, IX, 250—2; of differential equations of first order, x, 19.

**Integration:** a supposed new, VII, 36; theorem of, VII, 588; by series of differential equations, VIII, 458—62; a process of, IX, 257—8, x, 15, 29; indefinite, IX, 500—3; Aronhold's formula, x, 12—14; of Euler's equation, XI, 68—9.

**Integrator:** mechanical, XI, 52—4.

**Intercalation:** root-limitation, IX, 22—7; for right line, IX, 28—33; Sylvester's theory of, XIII, 46.

**Intermediates:** of two quantics, defined, II, 515; of binary quartic, II, 549; and ternary cubics, IV, 326.

**Intermutants:** the term, II, 19, 26, IV, 594, 600.

**Interpolation:** Smith's Prize dissertation, VIII, 551—5.

**Intersect-developable:** of two quadrics, I, 486—95.

**Intersections:** the term, VII, 546; of two curves, IX, 21, XII, 117—20; of cubic and line, XII, 100.

**Invariable Plane:** and rotation of solid body, I, 237, VI, 142.

**Invariants:** the term, I, 577, 589, II, 176, 224, IV, 594, 605, XIII, 46; and discriminants, I, 584; determined by differential equations, II, 164—78; and roots, II, 176; differential equation satisfied by, II, 176—8; and binary quantics, II, 266—8; of quartic, and covariants of cubic, analogous, II, 553; bibliography, II, 598—601; of biternary quantics, IV, 349—58; 18-thic of quintic in terms of roots, VI, 154—6; Cayley founder of, VIII, xxviii—xxx; his work, VIII, xxx—xxxii; and transformation of quantics, VIII, 385—7; quadratic transformation of a binary form, VIII, 398—400; identical equation connected with theory, IX, 52—5; Hessian of quaternary function, IX, 90—3; minimum N. G. F. of binary septic, x, 408—21; stereographic projection, XI, 187—9; in geometry, XI, 474; of a linear differential equation, XII, 390—3; Sylvester's work at, XIII, 46, 47; two, of quadri-quadric function, XIII, 67—8; differential, and reciprocants, XIII, 366—404; Pfaff-, XIII, 405—14; (*see also* Covariants, Linear Transformations, Seminvariants).

**Invariants and Covariants:** XII, 22—9; standard solutions of system of linear equations, XII, 19—21; finite number of the covariants of a binary quantic, XII, 558.

**Inversion:** of quadric surface, VIII, 67—71; note on, IX, 18.

**Inverts:** quadric function of, XI, 153—6.

**Involutant:** of two binary matrices, XIII, 74—5.

**Involution:** theory of geometrical, I, 259—66, 587; and two or more quadrics, II, 529—40; of six lines, IV, 582, VII, 66, 85, 95; lines in, v, 1—3; theory, v, 295—313; the term, VI, 460; of four circles, VI, 505—8; and ternary quadrics, XIII, 350—3.

**Involution of Cubic Curves, Memoir:** v, 313—53, VII, 238; explanations, definitions, and results, v, 314—8; general formulæ for critic centres, v, 318—9; twofold and one-with-twofold centre, v, 319—24; tangents at a node, v, 325—8; triangle of critic centres, v, 328—9; the three-centre conic, v, 329—36, 337—8; transformation equation of cubic, v, 339—41; cubic locus, harmoconics, and harmonic conic, v, 341—5; miscellaneous, v, 345—53.

**Irrational:** and subrational, IX, 315.

**Irreducible:** the term, VII, 336, XII, 23.

**Irreducible Concomitants:** of quintic, x, 342.

**Irreducible Covariants:** and invariants, II, 250.

**Irreducible Syzygies** (*see* Syzygies).

**Irregular:** the term, VI, 457, 459.

**Isecentric Lines:** and planet's orbit, VII, 468.

**Isobaric:** the term, XIII, 266.

**Isobarism:** of covariants, II, 233.

**Isochronic:** the term, nodal and cuspidal, VII, 473.

## ISOCHRONISM—JOHNSON.

106

**Isochronism** : of circular hodograph, III, 262—5.**Isomers** : Mathematical theory of, IX, 202—4.**Isoparametric Lines** : and planet's orbit, VII, 467.**Isoperimetrical Problem** : VII, 263.**Isothermals** : of Meyer, XIII, 175.

**Jacobi, K. G. J.** : theory of algebraic curves, I, 53; determinants, I, 63, 64, 66; quaternions, I, 126, 127, 586; inverse elliptic functions, I, 132, 136, 152, 156, 162, 180; rotation of solid body, I, 238, IV, 575, 576—7, 579; involution, I, 259, 263; definite integral, I, 270—1; dynamical differential equations, I, 276—9; elliptic functions, I, 290—300, 507, 587, XI, 452; demonstration of theorem on focal lines, I, 362—3; differential equations of Abelian functions, I, 366—9; skew determinants, I, 411; simultaneous linear transformations, I, 428; transformation of integrals, I, 440, 442; attraction of ellipsoids, I, 511—8; solution of equation  $x^{257} - 1 = 0$ , I, 564; Lagrange's theorem, II, 7; geometrical representation of elliptic integral, II, 56; in-and-circumscribed polygon, II, 141; partition of numbers, II, 248; lunar theory, III, 13; canonical formulæ for disturbed motion, III, 76—7; problem of three or more bodies, III, 102; transformation, III, 129; finite differences, III, 132—5; complete integral of partial differential equation, III, 166; planetary theory, III, 173; calculus of variations and differential equations, III, 174—84, 200, 202; *De Motu Puncti singularis*, III, 182—3, 202; problem of three bodies, III, 519—21, IV, 541, 548—51, 589, V, 23, VI, 183; *Theoria Novi Multiplicatoris*, III, 183—5; theory of ideal coordinates, III, 185; Encke's memoir *über die speciellen Störungen*, III, 179—80; in-and-circumscribed triangle, III, 236; disturbed elliptic motion, III, 270—1; canonical system of formulæ, III, 290; reversion of series, IV, 30—7; transformation of elliptic integrals, IV, 60, 64; double tangents, IV, 187; conics, IV, 207; Pfaff's problem, IV, 359—63; central forces problem, IV, 520, 589; *Nova Methodus*, IV, 515, 521, 589; elliptic motion, IV, 522, 589; problem of two centres, IV, 530, 532, 589; motion of a single particle, IV, 537—8, 589; motion in resisting medium, IV, 541, 589; motion of a point, IV, 547, 589; elimination of nodes, IV, 551, 589; transformation of coordinates, IV, 554, 557, 589; Weierstrass's function  $al(x)$ , V, 34—5; transformation of elliptic functions, V, 472, IX, 103, 113—75, XII, 59, 505—34; *Canon Arithmeticus*, VI, 83—6, XI, 85, 86; the Jacobian relation, VI, 467; geodesic lines on ellipsoid, VII, 493; transformation of double integral, IX, 250—2, 254; epispheric integrals, IX, 321, 410—17; mathematical tables, IX, 472—3, 484—5; series, X, 25—7; Poisson's theorem, X, 108—9, 110—3; theta functions, X, 156, 473, 478, 490, 496—7, XI, 41—6, XIII, 559; roots of unity, XI, 58—60; Schwarzian derivative and polyhedral functions, XI, 149; hypergeometric series, XI, 178; Landen's theorem, XI, 339; Abelian functions, XI, 454; theory of numbers, XI, 602; theorem in simultaneous equations, XII, 39; fraction theorem, XII, 123—5; Weierstrassian and Jacobian elliptic functions, XII, 425—7; sextic equation, XI, 389—401, XII, 493—9; sums of two series, XIII, 50; modular equations, XIII, 64; characteristic  $n$  and curves in space, XIII, 469; sextic resolvent equations, XIII, 473—9.

**Jacobian** : defined, II, 319, IV, 607; of two quantities, II, 517; theory of, and polyzomal curves, VI, 566—8; the extended notion, VII, 134; of surfaces, VII, 134—6; of two curves, IX, 21; of quadric surfaces, X, 568; of six points, X, 613; rational transformation, XIII, 116; (*see also* Quantics).

**Jefferson, T.** : founder of Virginian mathematical professorship, XIII, 43.**Jeffery, H. M.** : on quartic curves, XI, 408.**Jellett, J. H.** : theorem of, on attractions, I, 388—91.**Jenkins, M.** : Arbogast's method of derivations, IV, 609; problem in factorials, VII, 597.**Jerrard, G. B.** : quintics, IV, 391—4, V, 50—4, 77, 89; theory of equations, XI, 520.**Joachimsthal, F.** : theory of covariants, II, 177, 234; theorem of, II, 521, XII, 594—5, 601, 629; normals of a conic, IV, 74—7; attraction of terminated straight line, VII, 33.**Johnson, W. W.** : matrices, XI, 252.



- Jordan, C.:** trees, x, 599, XI, 366; substitutions, XI, 455; theory of equations, XI, 520—1; uniform convergence, XIII, 343—4.
- Joubert, P.:** transformation of elliptic functions, IX, 113, 138.
- Kant, I.:** cognition and space, XI, 431; negative magnitude, XI, 434.
- Kelland, P.:** quaternions, XII, 475.
- Kelvin, Lord:** equimomental surfaces, I, 253—4; definite integral, I, 270; differentiation and evaluation of definite integrals, I, 587; relative motion, IV, 535, 593; inertia, IV, 565, 566, 593; attraction of terminated straight line, VII, 33; report on mathematical tables, IX, 461—99; distribution of electricity, XI, 6.
- Kempe, A. B.:** theory of groups, XII, 639.
- Kenogram:** the term, IX, 202—3.
- Kepler, J.:** problem of, IV, 521; and ellipse, XI, 447.
- Key, T. H.:** Professor of Mathematics, University of Virginia, XIII, 43.
- Kiepert, L.:** transformation of elliptic functions, XII, 490—2.
- Kinematics:** of solid body, IV, 580—2; six coordinates of a line, VII, 89—95; of a plane, XI, 103—110, XIII, 505—16.
- Kirkman, T. P.:** schoolgirl problem, I, 483, 589; geometry of position, I, 550—6; sums of squares, II, 49—52; double summation of factorial expression, III, 250—3; autopolar polyhedra, IV, 85, 182; enumeration of polyhedra, v, 38; partitions of a polygon, XIII, 93.
- Klein, F.:** theory of distance, II, 604, VIII, xxxvi—vii; coordinates in non-Euclidian geometry, II, 604—6; non-Euclidian geometry, VIII, 409—13, XIII, 481; correspondence of homographies and rotations, x, 153; a system of quadric surfaces, x, 269; octahedral function, XI, 128; Schwarzian derivative and polyhedral functions, XI, 149, 151, 179, 183, 185; his classes of geometry, XI, 436; transformation of elliptic functions, XII, 29, 46, 490, 547.
- Knots:** of trees, III, 243, IX, 429—60, XI, 365—7, XIII, 26—8; in topography, defined, IV, 104.
- Königsberger, L.:** transformation of elliptic functions, IX, 113, 140; theta functions, x, 499.
- Korndörfer, G.:** quartic and quintic surfaces, VII, 246, 249, 252.
- Kowalski, M.:** orbit of Neptune, IX, 180.
- Kreistheilung:** (cyclotomy), XI, 58, 86.
- Kronecker, L.:** equation of differences, IV, 609—16; quintics, v, 55; theory of equations, XI, 520; sextic resolvent equations, XIII, 473—9.
- Kummer, E. E.:** solution of equation  $x^{257} - 1 = 0$ , I, 564; wave surfaces, I, 587; composition of numbers, IV, 70—1, 78—9; Steiner's quartic surface, v, 423; 16-nodal quartic surfaces, v, 431—7, VII, 126—7, x, 437; quartic surfaces, VII, 134, 176, 313, IX, 71; quintic surfaces, VII, 245, 247, 252; nodal quartic surfaces, VII, 264—297; surface of, VIII, 69; prepotentials, IX, 364; mathematical tables, IX, 494; double theta functions and 16-nodal quartic surface, x, 158, 161; octic surface, x, 252; theta functions, x, 499; table of hexads, x, 506, 538, 552; hypergeometric series, XI, 17—25, 177; Schwarzian derivative and polyhedral functions, XI, 149; theory of numbers, XI, 456; systems of rays, XII, 573; differential equation of third order, XIII, 69—73.
- Lachlan, R.:** circles and spheres, I, 581, XIII, 13.
- Lacroix, S. F.:** transformation of coordinates, IV, 557; imaginaries, XII, 468.
- Lacunary Functions:** XIII, 415—7.
- Ladd, Christine:** the Pascal hexagram, VI, 594.
- Lagrange, J. L.:** theorem of expansion, I, 40—2, 584, II, 1—7, III, 141; determinants, I, 64; variation of parameters, I, 243; dynamical differential equations, I, 279; elliptic functions, I, 366; distances of points, I, 581; attractions and multiple integrals, I, 581—2; caustics, II, 353; problem of two fixed centres, III, 104—10, IV, 527, 528—9, 589; sums of series, III, 124; *Mécanique Analytique*, III,

**LAGUERRE—LETTERS.**

108

157—8, 201, 202; equations of motion, III, 158, 200, IX, 198—200; planetary theory, III, 159—61, 162—3, 201; variation of arbitrary constants in mechanical problems, III, 161—5, 200, 201; coefficient ( $a$ ,  $b$ ) of, III, 163; Hamilton's method of dynamics, III, 171—3, 200; disturbed elliptic motion, III, 271—2; equations of differences, IV, 240, 252; resolvents, IV, 309; central forces problem, IV, 519—20, 589; elliptic motion, IV, 521—2, 589; expansion of anomalies, IV, 522; spherical pendulum, IV, 532—3, 589; rotation of solid body, IV, 566, 569, 589; homotypical functions, V, 50; invariable plane, VI, 142; invariants, VIII, xxx; demonstration of Taylor's theorem, VIII, 493—5, 519; virtual velocities, IX, 205—8; prime roots of unity, XI, 57; Schwarzian derivative, XI, 149; theory of equations, XI, 455, 498—500, 514—5, 517, 520; envelopes, XI, 475; minimal surfaces, XI, 638; five points in space, XII, 581—3; theorem of expansion and partitions of polygon, XIII, 113; Waring's formula, XIII, 215—6; reciprocants, XIII, 366; Richelot's integral of Euler's equation, XIII, 526.

**Laguerre, E.:** theory of matrices, II, 604.

**Lamb, H.:** conformal representation, X, 290.

**Lambdaic:** defined, II, 523, IV, 49, 53; of binary quartic, II, 550.

**Lambert, J. H.:** theorem on circular hodograph of, III, 262—5; theorem for elliptic motion, III, 562—5, VII, 387—9; central forces problem, IV, 519, 520, 589; equation of planet's orbit from three observations, VII, 412—5.

**Lamé, G.:** curvilinear coordinates, VIII, 146, XI, 637, XII, 17; orthogonal surfaces, VIII, 280, 291, 292.

**Lamp, Milner's:** a differential equation, and construction of, XIII, 3—5.

**Lancret, M. A.:** curves of curvature, XII, 601.

**Landen, J.:** theorem of, in elliptic functions, XI, 337—9; biographical notice, XI, 583—4.

**Languages:** Cayley's knowledge of, VIII, xxiii.

**Laplace, P. S.:** on Lagrange's theorem, I, 42, II, 7; determinants, I, 63; functions of, I, 397—401, 588; attraction of ellipsoids, I, 581, III, 53—65, 567; planetary theory, III, 159, 201; disturbed elliptic motion, III, 505, 510—11; on secular variation, III, 568; elliptic motion, IV, 524, 589; relative motion, IV, 534, 536, 589; motion of three bodies, IV, 540—1, 589; prepotentials, IX, 393; finite differences, XII, 412.

**Last Multiplier:** IV, 530, 547, 551, 590.

**Latin Squares:** XIII, 55—7.

**Latitude:** parametric, VII, 16, IX, 238.

**Lattice:** in theory of numbers, III, 40.

**Laverty, W. H.:** systems of equations, VII, 578.

**Law, The:** Cayley's work at, VIII, xiii—xv, xix.

**Lebesgue, V. A.:** determinants, I, 63.

**Lectures:** delivered by Cayley, VIII, xvi—xvii, xlv.

**Lefort, F.:** elliptic motion, IV, 522, 589.

**Left-handed:** circuits in root-limitation, IX, 22—3.

**Legendre, A. M.:** elliptic functions, I, 136, 156, 507, V, 618, XI, 452, 537, 584, XII, 35—7; elliptic integrals, I, 224; coefficients of, I, 375—6; attraction of ellipsoid, I, 432—7, 442; functions of, IV, 99, 106; rectilinear motion, IV, 516, 590; central forces problem, IV, 521, 590; problem of two centres, IV, 530, 590; rotation of solid body, IV, 570, 590; geodesic lines on oblate spheroid, VII, 15—25; reduced latitude, VII, 16; orbit of planet from three observations, VII, 414; mathematical tables, IX, 467—8, 478, 487; Landen's theorem, XI, 339; theory of numbers, XI, 455, 602—4, 616, XII, 35—7; second kind of coefficients, XII, 562—3; gamma function, XIII, 49.

**Lejeune-Dirichlet, P. G.:** multiple integrals, I, 195, 582—3; integration, I, 588; theorem of, II, 10, 47—8; binary quadratic forms, V, 141; prepotentials, IX, 321, 417—23; attractions, XI, 448; theory of numbers, XI, 456, 616.

**Lemniscate Function:** XI, 65; and orthomorphosis, XIII, 191—205.

**Letters:** substitution groups for two to eight, XIII, 117—49.

- Leverrier, U. J. J.:** disturbing function in planetary theory, III, 321, VII, 511—27; elliptic motion, III, 361, 362, IV, 523, 590; position of orbit in planetary theory, VII, 545.
- Lévy, M.:** orthogonal surfaces, VIII, 269, 569—70; Dupin's theorem, IX, 85.
- Light, Polarized:** MacCullagh's theorem, IV, 12—20.
- Limaçon of Pascal:** I, 480, XI, 477.
- Lindemann, F.:** non-Euclidian geometry, XIII, 481.
- Linear:** and omal relations in abstract geometry, VI, 463.
- Linear Differential Equations:** invariants of, XII, 390—3; general theory, XII, 394—402, 444—52; decomposition, XII, 403—7.
- Linear Equations:** and determinants, XI, 490; standard solutions of system of, XII, 19—21.
- Linear Function:** the term, XI, 492.
- Linear Quantics** (*see* Quantics).
- Linear Substitutions:** note on a function in, X, 307—9.
- Linear Transformations:** theory of, I, 80—94, 95—112, 117, 584, 585; Eisenstein's and Hesse's formulæ, I, 113—6, 585; homogeneous functions of third order with three variables, I, 230—3; hyperdeterminants, I, 352—5, 577—9, 588, 589; theory of permutations, I, 423—4; simultaneous, of two homogeneous functions of second order, I, 428—31; theory of permuted, II, 19—23; the term, IV, 594, 605; of elliptic integrals, IX, 618—21; of theta functions, XII, 50—5; Sylvester's work in, XIII, 46; (*see also* Covariants, Invariants, Quantics).
- Line-geometry:** and congruences, XIII, 228—30; (*see also* Coordinates, Lines).
- Lineo-linear:** the term, II, 517, IV, 604, VI, 464.
- Lineo-linear Transformation:** between planes, VII, 215—6, 236—8.
- Line-pairs:** the term, VI, 206, 209, 210, 211; through three given points and touching given conic, VI, 201, 244, 594.
- Line-pair-point:** the term, VI, 202, 210, 211, 269, 594—5.
- Lines:** on cubic surfaces, I, 445—56, VIII, 371—6; harmonic relation of two, II, 96—7; of cubic curve, II, 382; satellite, II, 383, V, 359; formulæ, II, 405—9; line, plane and point, defined, II, 561—2; contour and slope, IV, 108—11, 609; cubic centres and cones, IV, 173—8, 179—81; geometry of, IV, 446—55, 616—8; involution, IV, 582, V, 1—3; cubic centres of three lines and a line, V, 73—6; theorem of conic and triangle, V, 100—2; intersections of pencils of four and two, V, 484—6; formulæ for intersections of line and conic, V, 500—4; circle and parabola, problem, V, 607; notation in Pascal's theorem, VI, 116—23; facultative, VI, 365—6, 450; dot-notation for, and planes and cubic surfaces, VI, 365—6, 373—449; twenty-seven on cubic surface, VI, 371—87; attraction of terminated straight, VII, 31—3; five on cubic surface, VII, 177—8; homographic transformation, VII, 193—7; spherogram and isoparametric, VII, 467—8; iseccentric and *e*-spherogram, VII, 468—70; isochronic and time spherogram, VII, 470—7; Cayley's work on six coordinates of, VIII, xxxv; potentials of, IX, 278—80; formulæ relating to right, X, 287—9; and points, X, 570; and conics, X, 602; contact with a surface, XI, 281—93; Mill on, XI, 432—3; non-Euclidian geometry, XI, 437, XIII, 480—504; evolution of theory of curves, XI, 450—1; singularities of curves, XI, 468; in *Ency. Brit.*, XI, 548, 571—2; equation of right, XI, 558—61; and surface, XI, 629; Mascheroni's geometry of the compass, XII, 314—7; reciprocal, XIII, 58—9, 481; identity relating to six coordinates of a line, XIII, 76—8; and notion of plane curve of given order, XIII, 79—80; syzygetic relations, XIII, 224—7; of striction, on skew surface, XIII, 232—7; system of in a plane, and their orthotomic circle, XIII, 346—7; and point, distance, XIII, 495—7; theory of two lines, XIII, 497—504; (*see also* Coordinates, Curvature, Geodesic Lines).
- Line Systems:** two-dimensional geometry, II, 569—83.
- Link:** the term, V, 521, VII, 183, XIII, 506.
- Linkage:** the MacMahon, XIII, 265, 292, 293, 298—301.
- Link-work:** X, 407.

**LIOUVILLE—MANNHEIM.**

110

- Liouville, J.:** integration of differential equations, III, 180, 191—2; equations of motion, III, 185; Bour's memoir, III, 199, 204; a definite integral, IV, 28—9; elliptic motion, IV, 522, 590; problem of two centres, IV, 530; motion of three bodies, IV, 541, 590; point moving in plane, IV, 542—6, 590; Abelian integrals, IV, 546, 590; on roots of equations, IX, 39; indefinite integration, IX, 500—3; geodesic curvature, XI, 323, 328.
- Lipschitz, R.:** on Lagrange's equations, IX, 110—2.
- Listing, J. B.:** partitions of a close, V, 617, VI, 22; theorem of, VIII, 540—7.
- Lobatschewsky, N. I.:** geometry of, V, 471—2, VIII, xxxvii, XI, 436, XII, 220—38.
- Locus:** defined, IV, 458, VI, 458, 460; from two conics, VI, 27—34; in relation to triangle, VI, 53—64; and envelope in regard to triangle, VI, 72—82; *in solido*, problem and solution, VII, 599; *in plano*, problem and solution, VII, 599; the terms nodal-, cuspidal-, envelope-, tac-, VIII, 533—4; in *Ency. Brit.*, XI, 585.
- Logarithms:** theory of, III, 208—13, 222—8; of imaginary quantities, VI, 14—8; Pineto's tables, VIII, 95—6; calculation of log 2, XI, 70; origin, XI, 447; function in, XI, 526—7.
- Logic:** of characteristics, III, 51—2; calculus of, VIII, 65—6; Mill on, XI, 432—4; recent developments, XI, 458—9; geometry and algebra, XII, 459.
- Logistic:** and algebra, V, 293—4.
- London Mathematical Society:** Sylvester's connexion with, XIII, 45.
- Lottner, C. L. E.:** motion of solid body, IV, 583, 590.
- Lubbock, Sir J. W.:** theory of the Moon, III, 309—10.
- Lunar Theory:** Hansen's, III, 13—24; disturbed elliptic motion, III, 270—92; development of disturbing function, III, 293—318, 319—43, VII, 511—27; tables, III, 299—308; theorem of Jacobi, III, 519—21; Plana's, VII, 357—60, 361—6, 367—70, 371—4, 375—6; Delaunay's *l, g, h*, and *h+g*, VII, 528—33, 534; pair of differential equations in, VII, 535—6, 537—40; Newcomb's work, IX, 179—80; note on, XIII, 206—9; (*see also* Elliptic Motion, Disturbed).
- Lüroth, J.:** six coordinates of a line, VII, 66.
- Luther, E.:** theory of equations, XI, 520.
- MacAulay, A.:** quaternions and hydrodynamical equations, XIII, 8.
- MacClintock, E.:** quintics, IV, 609—16.
- MacCullagh, J.:** polar plane theorem, IV, 12—20; spherical conics, IV, 428; inertia, IV, 564—5, 588; rotation of solid body, IV, 574, 588.
- MacDowell, J.:** triangle and circle, V, 564.
- Maclaurin, C.:** cubic curves, I, 586; attraction of ellipsoids, III, 27, 62, 155; pedal curves, V, 113—4.
- MacMahon, P. A.:** symmetric functions, II, 603; seminvariants and symmetric functions, VIII, xxxi, XIII, 286—8, 290, 292, 293, 302; a differential equation, XII, 30—2; seminvariants, XII, 239, 254, 261, 275, 349, XIII, 265; a differential operator, XII, 318; Waring's formula for form of equation adopted by, XIII, 214; reciprocants and differential invariants, XIII, 399—404.
- Magic Squares:** x, 38.
- Magnetism:** Sabine's work, XI, 430; Gauss's work, XI, 544.
- Maillard, M. S.:** penultimate forms of curves, VIII, 258; degenerate forms of curves, XI, 220; systems of curves, XI, 487.
- Major Function in Abel's theorem:** XII, 111, 132—56.
- Malet, J. C.:** invariants, XII, 390—1.
- Malfatti, G. F.:** sextic resolvent equations, XIII, 473.
- Malfatti's Problem:** and system of equations, I, 465—70; Steiner's extension, II, 57—86, 593; Schellbach's solution, III, 44—7; system of equations connected with, IX, 546—50.
- Malus, É. L.:** systems of rays, XII, 573.
- Mannheim, A.:** epitrochoid, XIII, 81.

- Manuscript of Cayley**: facsimile of, on frontispiece, VIII.
- Maps**: surface representation on plane, VIII, 538–9; colouring, XI, 7–8; projections, XI, 448.
- Mars**: Newcomb on observations of, IX, 177.
- Marsano, G. B.**: mathematical tables, IX, 481–3.
- Martin, A.**: integration, X, 15, 29; probabilities, X, 600; Pellian equation, XIII, 467.
- Mascheroni, L.**: geometry of the compass, XII, 314–7.
- Masères, F.**: algebraic equations, IV, 171.
- Mathematical Society of London**: Sylvester's connexion with, XIII, 45.
- Mathematical Tables** (*see* Tables).
- Mathematics**: recent terminology, IV, 594–608; Mill on, XI, 432–4; relation to physics, XI, 444, 449; extent, XI, 449; Sylvester on its relation to music, XIII, 45.
- Matrices**: notation, II, 185–8, XI, 243; constituents being linear functions of one variable, II, 216–20; unity, II, 477; theory of, II, 475–96, 604, V, 438–48; which satisfy algebraic equation of own order, II, 483; convertible, II, 488; rectangular, II, 494–6; in automorphic linear transformation, II, 497–505; a linear system, II, 604; for reduction of quintic to Jerrard's form, IV, 392; the term, IV, 594, 601–2; Bezoutic, IV, 607; Cayley's method of verification, VIII, xxvii; Cayley the founder of theory, VIII, xxxii–iii; transformation of coordinates, XI, 136–42; of order two and the homographic function, XI, 252–7; quaternions, XII, 303, 311, 479; the equation,  $qQ - Qq' = 0$ , XII, 311–3; and theta function transformation, XII, 367–72, 386–9; quintic, XII, 376–80; Sylvester's theory of the corpus, XIII, 47; involutant of two binary, XIII, 74–5; six coordinates of a line, XIII, 76–8; note on a theorem in, XIII, 114; and sixty icosahedral substitutions, XIII, 552–7.
- Maurice, F.**: variation of arbitrary constants, III, 166, 202.
- Maxima**: of certain factorial functions, VIII, 548–9.
- Maxima and Minima**: of functions of three variables, I, 228–9; theorem in, IX, 40–1; theory of *déblais* and *remblais*, XI, 417–20.
- Maximum Indicator**: VI, 83.
- Maxwell, J. C.**: contour lines, IV, 609; quartic and quintic surfaces, VII, 246, 252; on Cayley, VIII, xx.
- Mean Motion** (*see* Motion).
- Mechanical Construction**: curve tracing, VIII, 179–80, XIII, 515–6; of Cartesians, IX, 317, 535–6; of conformable figures, X, 406.
- Mechanics**: variation of arbitrary constants in, III, 161–5, 200; construction of conformable figures, X, 406; integrator, XI, 52–4; and time, XI, 444; function in, XI, 522–3; curve tracing, XIII, 515–6.
- Mehler, F. G.**: attractions of polyhedra, IX, 266.
- Memoirs**: list of, on theoretical dynamics, IV, 584–593; (*see also* *Ency. Brit. and* the word desired).
- Mention, M.**: in-and-circumscribed polygon, IV, 294, 303–5.
- Mercator's Projection**: VIII, 567, IX, 237–40.
- Merrifield, C. W.**: letter to, VIII, 517–8.
- Mersenne, M.**: the cycloid, XI, 447.
- Metageometry** (*see* Hypergeometry, Prepotentials).
- Method of Derivations**: Arbogast's, II, 257, IV, 265–71, 272–5, 609, XI, 55; binomial theorem and factorials, VIII, 463–73.
- Methyl**: trees of, IX, 544–5.
- Metrical Geometry**: II, 592.
- Metrical Theory**: pure analytical geometry, XI, 556–7; solid geometry, XI, 570.
- Meunier, J. B. M. C.**: theorem of, III, 38.
- Meyer, F.**: history of quantics, VIII, xxxi; orthomorphosis, XIII, 175, 187.
- Mill, J. S.**: logic and mathematics, XI, 432–4.
- Miller, W. J. C.**: triangles, V, 566; conics, V, 582; negative pedals of ellipsoid and ellipse, X, 576–7; geometrical interpretation, X, 604.

**MILNER—MULTIPLICATION.**

112

- Milner's Lamp** : differential equation and construction of, XIII, 3—5.
- Minima** (*see* Maxima and Minima).
- Minimal Surfaces** (*see* Surfaces).
- Minor** : the term, XI, 496.
- Minor Function** : in Abel's theorem, XII, 111.
- Mirrors** : systems of rays, XII, 571—5.
- Möbius, A. F.** : geometry of position, I, 360; reciprocal figures, I, 415; developable from quintic curve, I, 500; tortuous curves, I, 500; circular relation, III, 118—9, IX, 612—7, XI, 188; cubic curves, IV, 120, XI, 479; in-and-circumscribed triangle, IV, 439—41; cubic curves and cones, V, 401, 551; opposite curves, V, 468; equilibrium of four forces, V, 540—1; coordinates of a line, VII, 66, 93; multiple algebra, XII, 472, 473.
- Models** : Plücker's, of quartic surfaces, VII, 298—302; Wiener's, of cubic surface, VIII, 366—84.
- Modular** : the term, XIII, 559.
- Modular Equations** : in elliptic functions, IX, 117—8, 126—37, 169—75, XII, 507—34; errors in Sohnke's paper, IX, 543; for cubic transformation, XII, 46; quintic transformation, XII, 416.
- Modular Functions** : system of symbols, IV, 484—9;  $\chi\omega$ , XIII, 338—41.
- Modulus** : of transformation, the term, IV, 605; table for any prime or composite, VI, 83—6.
- Moment** : non-Euclidian geometry, XIII, 481—9.
- Moment of Inertia** : of solid body, IV, 478—80, 559—66.
- Monge, G.** : transformation of coordinates, IV, 557; theory of *déblais* and *remblais*, XI, 417—20; descriptive geometry, XI, 448—9; reciprocal polars, XI, 465; biographical notice, XI, 586—8; non-Euclidian plane geometry, XII, 221; differential equation of conic, XII, 393.
- Monodromic** : the term, XII, 432.
- Monogenic Function** : XI, 80, 537.
- Monoid Surfaces** : and curves in space, V, 8, 552; and quintic curves in space, V, 24—30, 552, 553, 613.
- Monotropic** : the term, XII, 432.
- Monro, C. J.** : flexure of spaces, X, 331—2.
- Montucla, J. F.** : on Wallis, XI, 642.
- Moon** : secular acceleration of mean motion, III, 522—61, 568; (*see also* Lunar Theory, Solar Eclipse).
- Morley, F.** : topology of chessboard, X, 609—10; systems of circles and spheres, XIII, 13.
- Motion** : of solid body, I, 28—35, 583; secular acceleration of moon's, III, 522—61, 568; Lagrange's equations of, IX, 198—200; on three-bar, IX, 551—80, 585, XIII, 505—16; Sylvester on recent discoveries in mechanical conversion, XIII, 44; (*see also* Dynamics, Elliptic Motion, Kinematics, Lunar Theory).
- Motte, A.** : problem of tactions, XIII, 151.
- Moulton, J. F.** : matrices, XI, 256.
- Mountains** : altitude, and roots of algebraic equation, XIII, 33—7.
- Mourey, C. V.** : imaginaries, XII, 468.
- Mousetrap** : the game of, III, 8, X, 256—8.
- Moutard, T.** : quartic surfaces, VII, 246, VIII, 262.
- Muir, T.** : history of determinants, I, 581; problem of arrangements, X, 249—51; elimination, XIII, 545—7.
- Multiform Series** : defined, IV, 456.
- Multilinear Operator of MacMahon** : XIII, 399.
- Multiple Algebra** : on, XI, 446, XII, 60—71, 459—89; associative imaginaries, XII, 105—6.
- Multiple Integrals** : and attractions, I, 5—12, 13—8, 195—203, 204—6, 285—9, 438—44, 581, 586, II, 35—9; demonstration of a theorem of Boole, I, 384—7, 588.
- Multiple Sines** : X, 1—2.
- Multiple Theta-functions** (*see* Theta-functions).
- Multiplication** : of elliptic functions, I, 534—9, 568—76, 589, IX, 138—47, XII, 507; of determinants,

- xi, 495; of extraordinaries, xii, 461—2; complex, in elliptic functions, xii, 556—7; (*see also* Transformation).
- Multiplier**: Jacobi's theory of, i, 276, 279; theory of, in differential equations, x, 102—6; in elliptic integrals, x, 139.
- Multiplier Equations**: in elliptic functions, ix, 138—47, xii, 507.
- Murdoch, P.**: *Newtoni Genesis Curvarum per Umbras*, v, 284, 288; curve classification, v, 354; cubic curves and cones, v, 402; the simplex cubical parabola, vi, 101.
- Murphy, H.**: four points in plane or space, vii, 585.
- Murphy, R.**: Legendre's coefficients, i, 376.
- Music and Mathematics**: Sylvester on, xiii, 45.
- Napier, J.**: logarithms, xi, 447.
- Natani, L.**: Pfaffian equations, iv, 515.
- Nature*: notice on Sylvester, xiii, 43—8.
- Neg**: the abbreviation in groups, xiii, 119.
- Negative**: the rule of signs, iv, 595—6, xi, 492.
- Negative Deficiency**: viii, 397.
- Neptune**: Newcomb's astronomical work, ix, 180—4.
- Neutral**: the term, vi, 101.
- Newcomb, S.**: astronomical work of, ix, 176—84.
- Newton, Sir I.**: cubic curves, iv, 122; rectilinear motion, iv, 515, 590; central forces, iv, 515, 590; parabolas, v, 284; curve classification, v, 354, 364—6, 396—9; diameter, v, 362; cubic curves, v, 401, 551, xi, 464; conics, v, 562; forms of cubical parabolas, vi, 101; theorem as to roots of equations, x, 5; *Principia*, xi, 447—8; branches of curves, xi, 477; theory of equations, xi, 500, 502; roots of algebraic equation, xiii, 35; Sylvester's work at rule of, xiii, 46; tactions, xiii, 151—69; Newton-circle, the term, xiii, 152.
- Newton-Fourier Theorem**: imaginary roots, x, 405—6, xi, 143, xiii, 36; extension to complex variables, x, 405—6; theory of equations, xi, 114—21, 122.
- Nexal**: the term, viii, 73.
- Nil**: the term, xii, 66.
- Nilfactum**: and quantic, vi, 466.
- Nilpotent**: the term, xii, 61.
- Nilvalent**: the word, ix, 202.
- Nine-point Circle**: xiii, 517—9, 520—1, 548—51.
- Nitrogen**: tree of, ix, 430.
- Nivellators**: Sylvester's theory of, xiii, 47.
- Nodal**: the term, vii, 244.
- Nodal Anallagmatic**: the term, viii, 67.
- Nodal Bicircular Quartic**: mechanical description, vii, 182—8.
- Nodal Cubic**: vi, 171—4, vii, 555.
- Nodal Curves**: of developable from quartic, v, 135—7; of cubic surface, vi, 450; centro-surface of ellipsoid, viii, 332—52.
- Nodal Director**: the term, v, 169—70.
- Nodal Generator of Scrolls**: v, 169—70, 179—81.
- Nodal Isochronic**: the term, vii, 473.
- Nodal Locus**: in singular solutions, viii, 533.
- Nodal Quartic**: defined, v, 10; mechanical description of bicircular, vii, 182—8; and hyperelliptic functions, xii, 196—208.
- Nodal Quartic Surfaces** (*see* Quartic Surfaces).

**NODAL—NUTATION.**

114

**Nodal Residue of Scrolls** : v, 169—70, 181—3, 184, 187.**Nodal Total of Scrolls** : v, 169—70, 183—9.**Node-couple** : defined, II, 29, IV, 22, XI, 227; curve, and plane, and torse, VI, 355, 582—5; torse, VI, 601.**Node-cusp** : v, 265—6, 618.**Node-form** : the term, VII, 274.**Nodes** : the term, II, 28, IV, 22, 27, 181, v, 295, XI, 468; elimination of, in three bodies, IV, 551, v, 23; number on quartic surface, VII, 133—81; quartic surface with twelve, XIII, 1—2.**Node-tangent** : defined, II, 29—32.**Node-triplet** : the term, II, 30.**Nodo-focus** : of bicircular quartic, VI, 522—3, 523—6; the term, IX, 264.**Non-commutative Algebra** (*see* Algebra).**Non-Euclidian Geometry, Memoir on** : introduction, XIII, 480—1; geometrical notions, XIII, 481—9; point, line, and plane coordinates, general formulæ, XIII, 489—91; the absolute, XIII, 491—5; distance of a point and line, XIII, 495—7; distance of a plane and line, XIII, 497; theory of two lines, XIII, 497—504.**Non-Euclidian Geometry** : VIII, 409—13, XII, 220—38; (*see also* Hypergeometry).**Non-facultative Space** : VI, 156.**Non-scalar Surfaces** : quartic and quintic, VII, 245.**Non-unitariants** : the term, XIII, 265.**Non-unitary Symmetric Functions** : and seminvariants, XII, 239, 275, XIII, 267—98; tables, XII, 273—4.**Norm** : and polyzomal curves, VI, 474, 573—5.**Normal Elementary Integral** : of differential equation, XII, 396—7, 444.**Normals** : in *Ency. Brit.*, XI, 564—5; (*see also* Conics).**Normal Variables** : in dynamics, IX, 111.**Notation** : algebraic functions, II, 185—8; matrices, II, 185—8; quantics, II, 223; for disturbing function compared, III, 310—8; quantics and abstract geometry, VI, 464—6; differential equations, x, 95—7; for double theta functions, x, 497; theta functions, XI, 47—9, 243—5; umbral, XIII, 301—6.**Nöther, M.** : curves in space, v, 613—7; rational transformation, VII, 255; deficiency of surfaces, VIII, 395; sextic curve, IX, 504—7; classification of curves, XI, 451; Abelian function, XII, 149.**Novel-reading** : at Cambridge by Cayley, VIII, x—xi, xxiii.**Nullity** : Sylvester's theory of, XIII, 47.**Number** : time, and space, v, 292, 620, XI, 442—4; theory of equations, XI, 502.**Numbers** : a theorem of Lejeune-Dirichlet's, II, 47—8; tables of binary cubic forms, VIII, 51—64; use of Bernoulli's, in analysis, IX, 259—62; arrangements of, x, 570; Sylvester and Hammond on Hamiltonian, XIII, 48; (*see also* Partition of Numbers).**Numbers, Theory of, in *Ency. Brit.*** : XI, 592—616; ordinary and complex theories, XI, 592—3; ordinary theory, XI, 594—609, 615—6; theory of forms, XI, 604—9; complex theories, XI, 609—16.**Numbers, Theory of** : Pellian equation, IV, 40—2, IX, 477—8, XI, 615, XIII, 430—67; composition of, IV, 70—1, 78—9; specimen table, VI, 83—6;  $x^p - 1 = 0$ , trisection and quartisection, XI, 84—96;  $x^p - 1 = 0$ , and quinquisection, XI, 314—6, XII, 72—3; H. J. S. Smith on, XI, 429; imaginaries, XI, 444—5; evolution, XI, 455—6; Wilson's theorem, XII, 45; Sylvester on, XIII, 47; (*see also* Partition of Numbers).**Numerative Geometry** : Schubert's, XI, 281—93.**Numerical Equations** : x, 3—6.**Numerical Expansions** : IV, 470—2.**Numerical Generating Function** : x, 339, 408.**Nutation** : note on theory of, IX, 194—6.



- Obliquity**: the term, XIII, 234.
- Observations** (*see* Orbits, Planet's Orbit, Solar Eclipse).
- Octacron**: enumeration of polyhedra, v, 38—44.
- Octad**: the term, I, 586, VII, 133, 152, XII, 590.
- Octadic-quartic Surfaces**: x, 51.
- Octagon**: theorem of eight points on a conic, VIII, 92—4.
- Octahedral Function**: XI, 128—9.
- Octahedron**: axial system, v, 531—9; automorphic function for, XI, 169, 179—83, 212—6.
- Octaves**: elliptic functions, I, 127, 586; imaginaries, I, 301.
- Octavic Surface**: VIII, 401—3.
- Octic Function**: and Abelian function, XI, 483.
- Octics**: and twisted cubics, XII, 310.
- Octic Surface**: on a sibi-reciprocal, x, 252—5; (*see also* Surfaces).
- Octo-dianome**: the term, VII, 134.
- Octo-hexahedron**: the term, x, 328.
- Odd Branch of Curve**: x, 36.
- Off-planes**: the term, VI, 330, 577, 583—5.
- Off-points**: the term, VI, 330, 338, 577, 583—5.
- Olbers, W.**: orbits of asteroids, IX, 177.
- Olivier, T.**: conics inscribed in quadric surface, I, 557.
- Omali**: the word, VI, 194, 463, 467—9.
- Omega Functions**: the term, XI, 453; note on Smith's memoir, XIII, 558—9.
- Omphali**: the term, VIII, 326.
- Operandator**: defined, III, 242.
- Operations**: and substitutions, XIII, 530.
- Operators**: differential, VII, 8; and seminvariants, XIII, 322—32; MacMahon's multilinear, XIII, 399.
- Optics**: MacCullagh's theorem in polarized light, IV, 12—20; geometrical construction in, x, 28.
- Orbits**: Jacobi's canonical formulæ for disturbed motion, III, 76—7; reduction to fixed plane, III, 91—6; variation in plane of planet's, III, 516—8; central forces problem, IV, 516—21; position of, in planetary theory, VII, 541—5; of asteroid, and Newcomb, IX, 176—7; Hamiltonian equations of central, x, 613; Sylvester's work at, XIII, 47; (*see also* Planetary Theory, Planet's Orbit).
- Order**: of system of equations, I, 457—61, 589; of quantics, defined, II, 221; of curve, II, 569—83, XI, 462; in abstract geometry, defined, VI, 463; of curve and surface, XI, 629.
- Ordinary Point for Differential Equations**: XII, 394.
- Oriani, B.**: elliptic motion, III, 474, IV, 528.
- Orr, W. McF.**: tetrads of circles, XIII, 425.
- Orthocentre**: the term, XIII, 550.
- Orthogonal Surfaces**: VIII, 269—91, 292, 569—70; Smith's Prize dissertation, VIII, 558—63.
- Orthogonal Surfaces and Curvature, Memoir on**: VIII, 292—315; introductory, VIII, 292—3; curvature of surfaces, VIII, 293—300; conormal correspondence of vicinal surfaces, VIII, 301—8; condition that the two surfaces may belong to orthogonal system, VIII, 309—11; family of surfaces, VIII, 312—5.
- Orthomorphic Transformation** (*see* Orthomorphosis).
- Orthomorphosis**: of circle into parabola, v, 618, XII, 328—36; of a circle into itself, XIII, 20; general theory, XIII, 170—90; some problems, XIII, 191—205; note on theory, XIII, 418—24; (*see also* Conformal Representation).
- Orthotomic**: the term, IX, 13.
- Orthotomic Circles**: and polyzomal curves, VI, 501; and Jacobians, VI, 568.
- Orthotomic Curve**: of a system of lines in a plane, XIII, 346—7.
- Orthotomic Surfaces**: in *Ency. Brit.*, XI, 637—8.

**OSCNODE—PEDAL.**

116

- Oscnode**: defined, II, 28—32.
- Oscular**: the term, VI, 334, 361, 362.
- Ostrogradsky, M. A.**: dynamic equations, III, 186, 203; transformation of differential equations, IV, 514; virtual velocities, IX, 207.
- Outcrops**: the term, VIII, 326, 351.
- Oval Chuck for Quartic Curves**: VIII, 151—5.
- Ovals**: of Descartes, I, 479, II, 118, 336, III, 66; and quartic curves, V, 468—70; twice-indented, X, 318; and functions, XI, 540; in *Ency. Brit.*, XI, 549—51; roots of algebraic equations, XIII, 37; Sylvester's work at, XIII, 47; orthomorphosis, XIII, 185—6, 202.
- Oxygen**: trees of, IX, 427—60.
- II**: Wallis's investigation for, XIII, 22—5.
- Pagani, G. M.**: central forces problem, IV, 520, 590; motion of solid body, IV, 583, 590.
- Painvin, L.**: last multiplier, IV, 551, 590.
- Parabola**: inflexions of cubical divergent, V, 284—8, VI, 101—4; classification, V, 356, 395, VI, 101; line and circle, problem, V, 607; polyzomal curves, VI, 542; cubic curves, XI, 478; in *Ency. Brit.*, XI, 548—51, 561—4; orthomorphosis of circle into, XII, 328—36; and epitrochoid, XIII, 86—7; orthomorphosis into circle, XIII, 421—2.
- Parabolic Cyclide**: IX, 73—8.
- Paraboloids**: in *Ency. Brit.*, XI, 576—9.
- Paradox**: the d'Alembert-Carnot geometrical, XII, 305—6.
- Paraffins**: trees of, IX, 427—60.
- Parallel Curves**: envelopes and surfaces, IV, 123—33, 152—7, 158—65; and evolutes, VIII, 31—5; theory of, X, 260; the critic in solar eclipses, X, 311—5.
- Parallels**: and non-Euclidian geometry, XIII, 480—1, 481—9; the terms right and left, XIII, 488, 502.
- Parallel Surfaces**: of paraboloid, VIII, 7; of ellipsoid, VIII, 9, IX, 591; in *Ency. Brit.*, X, 637—8.
- Parametric Class and Order**: of systems of cones, V, 552.
- Parametric Latitude**: VII, 16, IX, 238.
- Parametric Relation**: VI, 463—4; of triple orthogonal system, VIII, 292—315.
- Parazome**: the word, VI, 477.
- Partial Differential Equations**: integral of, III, 166; system of, VIII, 517—8; Jacobi's, in transformation of elliptic functions, XII, 530—3; on a, XIII, 358—61.
- Particle**: under central forces, X, 575; (*see also* Dynamics).
- Partition of Numbers**: II, 218, 235—49, V, 48; and quantics, II, 265; supplementary researches, II, 506—12; a problem in, III, 247—9; tactical, V, 294, XI, 443.
- Partitions**: conjugate, due to Ferrers, II, 419; formulæ in, III, 36—7; problem of double, IV, 166—70; of a close, V, 62—5, 617; problems, VII, 575, X, 611, XI, 61—2; tables, IX, 480—3, XI, 357—64; theorems in trigonometry and, X, 16; in *Ency. Brit.*, XI, 589—91; note on a partition-series, XII, 217—9; non-unitary partition, XII, 273—4; Sylvester's constructive theory of, XIII, 47; of a polygon, XIII, 93—113; and seminvariants, XIII, 269.
- Pascal, B.**: hexagram of, I, 356; limaçon of, I, 480; some theorems of geometry of position, I, 550—6; lines of, I, 551, 588; curves, XI, 447; inscribed hexagon, XI, 556.
- Pascal's Theorem**: intersection of curves, I, 25—7; demonstration, I, 43—5; Chasles' form of, I, 45; on, I, 322—8, 414, VI, 129—34, 594; generalized, V, 4; notation of points and lines, VI, 116—22, 594.
- Peacock, G.**: multiple algebra, XII, 460, 467, 469, 470—1.
- Peaucellier, A.**: mechanical construction of Cartesian by his cell, IX, 317; cell of, and scalene transformation, IX, 527—34; Sylvester on his discoveries, XIII, 44.
- Pedal Curves**: Maclaurin on, V, 113—4.

- Peirce, B.**: orbit of Neptune and Uranus, ix, 180, 182; multiple algebra, xi, 457—8, xii, 60—71; associative algebras, xii, 106, 459, 465; imaginaries, xii, 303.
- Pellian Equation**: iv, 40—2; tables, ix, 477—80; and theory of numbers, xi, 615; report of committee on, xiii, 430—67.
- Pencils**: defined, ii, 577; homography of, ii, 578; intersections of four- and two-lined, v, 484—6; of six lines and cubic curves, vi, 105—15, 593—4.
- Pendulum, Spherical**: iv, 532—4, 535—7, 541.
- Peninvariants**: and seminvariants, iv, 241; the term, iv, 606.
- Pentagon**: a theorem relating to, i, 318—9; Gauss's *Pentagramma Mirificum*, vii, 37—8; Schröter's construction of regular, xii, 47; (*see also* Polygons).
- Pentagramma Mirificum*: of Gauss, vii, 37—8.
- Pentagraph**: illustrating a function, xi, 440; curve tracing, xiii, 515—6.
- Penultimate Forms**: of curves, viii, 258—61; of surfaces, viii, 262—3.
- Penultimate Quartic Curve**: viii, 526—8.
- Penumbral Curve** (*see* Solar Eclipse).
- Periodic Functions**: the term, xi, 529; (*see also* Doubly Periodic Functions).
- Periods**: of elliptic integrals, ix, 618; of theta functions, x, 467—9.
- Permissive Points**: in differential equations, xii, 434—41.
- Permutants**: theory of, ii, 16—26, 27; defined, ii, 17, iv, 594, 596, 600; Sylvester on, ii, 26—7.
- Permutations**: theory of, i, 423—4; idea of group, ii, 124; problem of geometric, v, 493—4; commutants, v, 495—7; colours on faces of polyhedra, v, 539; (*see also* Arrangements, Combinatory Analysis).
- Perott, J.**: binary quadratic forms, v, 618.
- Perpendicular**: in non-Euclidian geometry, xiii, 480—1, 481—9.
- Perpendicularity**: and imaginaries, xii, 466—72.
- Perpetuants**: and seminvariants, xii, 250—7, xiii, 266; sextic, xii, 257—62; reducible seminvariants, xiii, 308—13; Strohian theory of, xiii, 314—8.
- Perspective**: of triangles, iii, 5; five points in a plane, v, 480—3; theory, xi, 442.
- Pfaff, J. F.**: problem, iv, 359—63.
- Pfaffian Differentials**: xiii, 361, 405—14.
- Pfaffian Equations**: Natani and Clebsch, iv, 515.
- Pfaffians**: and skew determinants, i, 411, ii, 203; the term, i, 589, ii, 19, iv, 594, 600; and differential equations, x, 96—7, 106.
- Pfaff invariants**: xiii, 405—14.
- Physics**: relation to mathematics, xi, 444, 449; (*see also* Dynamics, Electricity, Light).
- Picard, É.**: integral calculus, xii, 408—11.
- Pinch-planes**: the term, vi, 330, 335, 583—5, x, 53—6.
- Pinch-points**: the term, vi, 123, 330, 335, 582—5, x, 53—6, xi, 227.
- Pineto, S.**: tables of logarithms (review), viii, 95—6.
- Pippian**: defined, i, 586, ii, 381, 397—400, 400—3; and Hessian, ii, 383—95; geometrical definition, ii, 416.
- Pirie, B.**: inertia, iv, 564.
- Plana, G. A. A.**: lunar theory, iii, 536, 568, vii, 357—60, 361—6, 367—70, 371—4, 375—6; distribution of electricity, iv, 92, 100—7.
- Planar Developables**: the term, i, 505.
- Planarity**: of developables, v, 517.
- Plane Curves** (*see* Curves, Plane).
- Plane-integral**: prepotential, ix, 337—43.
- Plane of Orbit**: variation in, iii, 516—8.

**PLANE—POINT.**

118

**Plane Representation of Solids:** VII, 26—30.**Planes:** diametral, of quadric surface, I, 255—8; point and line defined, II, 561—2; geometry of two dimensions, II, 569—83; MacCullagh's theorem of polar, IV, 12—20; lines and dots of cubic surfaces, VI, 365—6, 373—449; rational transformation, VII, 197—213, 216—9; quadric transformation, VII, 213—6; also lineo-linear, VII, 215—6; determined by point and three lines, VII, 571; flecnodal, of a surface, X, 262—4; kinematics of, XI, 103—10, XIII, 505—16; in *Ency. Brit.*, XI, 571—2; osculating and normal, XI, 579—80; and surface, XI, 629; non-Euclidian geometry, XIII, 481—504; and line distance, XIII, 497.**Planetary Theory:** Desboves', III, 185, 203; development of disturbing function, III, 319—43, VII, 511—27; variation in plane of orbit, III, 516—8, VII, 541—5; theorem of Jacobi, III, 519—21; Newcomb's work, IX, 180—4.**Planets:** angular distance of two, VII, 377—9.**Planet's Orbit from Three Observations:** VII, 384—6, 400—78; introductory, VII, 400—1; the general theory, VII, 401—6; determination of orbit from given trivector, VII, 406—12; time formulæ, Lambert's equation, VII, 412—5; formulæ for transformation between two sets of rectangular axes, VII, 415—7; intersection of orbit plane by single ray, VII, 417—26; trivector and orbit, VII, 426—8; special symmetrical system of three rays, VII, 428—9; Planogram No. 1, meridian  $90^\circ$ — $270^\circ$ , VII, 429, 430—40; No. 2, meridian  $0^\circ$ — $180^\circ$ , VII, 429, 441—51; No. 3, orbit-pole at point *A*, VII, 429, 452—4; No. 4, orbit-pole in ecliptic, VII, 429, 455—9; No. 5, orbit-pole on a separator, VII, 429, 459—67; spherogram and isoparametric lines, VII, 467—8; *e*-spherogram and iseccentric lines, VII, 468—70; time-spherogram and isochronic lines, VII, 470—7.**Planogram:** the term, VII, 404; three plates, VII, to face 478; meridian  $90^\circ$ — $270^\circ$ , VII, 429, 430—40;  $0^\circ$ — $180^\circ$ , VII, 429, 441—51; orbit-pole at point *A*, VII, 429, 452—4; in ecliptic, VII, 429, 455—9; on separator, VII, 429, 459—67.**Plates** (*see* Diagrams, *also* Tables).**Plato:** and geometry, XI, 446.**Playfair, J.:** on twelfth axiom of Euclid, XI, 435.**Plerogram:** the term, IX, 202.**Plexus:** the term, IV, 603, VI, 458; Sylvester's term, XIII, 46.**Plücker, J.:** theory of algebraic curves, I, 53, 54; curves and developables, I, 207, 208, 210, 586—7; involution, I, 259, 261; elimination, and theory of curves, I, 344; geometry of position, I, 356, 553—6; geometrical reciprocity, I, 380; reciprocal figures, I, 418; quadric surfaces, I, 421; cubic surfaces, I, 446; transformation of curves, I, 478; singularities of plane curves, I, 586, V, 520—2, 619, XI, 450; cubic curves and cones, IV, 173—8; double tangents, IV, 186; points of six-pointic contact on cubic, IV, 207; cubic curves, IV, 495, 617, V, 402; line geometry, IV, 616—8; hyperboloid coordinates, V, 72; node-cusp, V, 265—6; curve classification, V, 354—400; numbers for singularities of plane curves, V, 424, 476, 517; higher singularities of plane curves, V, 426, 619; pencil intersections, V, 484; numbers of, VI, 68, VIII, 41—5, XI, 469—73; species of cubical parabola, VI, 101; focus, VI, 515, XI, 481; six coordinates of a line, VII, 66; quartic surface models, VII, 298—302; construction of a conic, VII, 592; hypergeometry, VIII, xxxv; theory of curve and torse, VIII, 74, 75—6, 80—1; theory of curves, XI, 467; envelopes, XI, 475—6; note on equations of, XIII, 536.**Pohlke, K.:** theorem in axonometry, IX, 508.**Poincaré, H.:** lacunary functions, XIII, 415.**Poinsot, L.:** polygons and polyhedra, IV, 81—5, 86—7, 609; inertia, IV, 563, 590—1; rotation of solid body, IV, 571—3, 577, 591; kinematics of solid body, IV, 580, 581, 591.**Point:** of cubic curve, II, 382; satellite, II, 383; formulæ, II, 405—9; theorems, II, 409—12; plane and line defined, II, 561—2; and ineunt of a curve, II, 574; lattice, III, 40; distances of, from triangle and formulæ, IV, 510—2; tritom, V, 138; the term polar of, V, 570; and abstract

geometry, VI, 458; potential of, IX, 278—80; singularities of curves, XI, 468; coordinates of, as functions of parameter, XII, 290—1; and line distance, XIII, 495—7; two-way, XIII, 507; for-forwards, and back-backwards, XIII, 510.

**Point-pairs:** the term, II, 564—5, VI, 202, 206—7, 208, 210, 269, 594—5; degenerate forms of curves, XI, 218.

**Points:** distances of, I, 1—4, 581; some theorems in geometry of position, I, 317—28; of inflexion, I, 345—9, 354; of osculation, I, 349—51; harmonic relation of two, II, 96—7; of cesser, defined, IV, 130; critical defined, IV, 130; five in a plane, V, 480—3; correspondence on plane curve of, V, 542—5; and circle, problem, V, 560; correspondence of two on a curve, VI, 9—13, 264—8, VII, 39; notation of, in Pascal's theorem, VI, 116—23; abstract geometry, VI, 463; consecutive, VI, 467—9; system of 16, and polyzomal curves, VI, 501—3, 504—5; problem of random, VII, 585; problem and solution of four in plane or space, VII, 585; four and conic, VII, 587; on particular sextic curve, IX, 504—7; branch- and cross-, X, 317; and lines, problem and solution, X, 570; on a circle, function of, XI, 130; double- and pinch-, XI, 227; Mill on, XI, 432—3; representation on plane, XI, 442; evolution theory of curves, XI, 450—1; at infinity, XI, 464; relation between the distance of five in space, XII, 581—3; analytical formulæ in regard to octad of, XII, 590—3; Sylvester's facultative, XIII, 46; non-existence of a special group, XIII, 212; syzygetic relations, XIII, 224—7; non-Euclidian geometry, XIII, 480—504; coordinates of, and non-Euclidian geometry, XIII, 489—91; (*see also* Orthomorphosis).

**Point-systems:** and one-dimensional geometry, II, 563—9, 583—86; and two-dimensional geometry, II, 569—83, 586—92.

**Poisson, S. D.:** attraction of ellipsoids, III, 155; planetary theory, III, 159, 201; variation of arbitrary constants in mechanical problems, III, 163—5, 200, 201, 202; coefficient ( $a, b$ ) of, III, 163; Hamilton's method of dynamics, III, 173—4, 200; integration of differential equations, III, 180; distribution of electricity, IV, 92—5, 100—7, X, 299, XI, 1; elliptic motion, IV, 522; relative motion, IV, 535, 591; motion of projectile, IV, 541, 591; inertia, IV, 563, 591; rotation of solid body, IV, 566, 569, 573, 591; rotation round fixed point, IV, 582, 591; motion of solid body, IV, 583, 591; attraction of ellipsoidal shell, IX, 302; Jacobi's theorem, X, 108—9, 110—3.

**Polar:** of point, V, 570, X, 54, XI, 465.

**Polar Conjugate:** of curve of third class, II, 383.

**Polar Reciprocal:** I, 230, 378, 416.

**Polarization:** MacCullagh's theorem, IV, 12—20.

**Poles:** conjugate, of cubic curve, II, 382—5; two-dimensional geometry, II, 579—83, 586—92; the term, XI, 465.

**Pollock, Sir F.:** on circumscribed triangle, III, 29—34.

**Poloid Curve:** IV, 571—2.

**Polyacra:** triangle-faced, and enumeration of polyhedra, V, 38—44.

**Polygons:** in-and-circumscribed, II, 87—9, 91—2, 138—44, 145—9, IV, 292—308, 435—41, V, 21—2, VIII, 14—21, 212; partitions of close-, V, 62—5, 617; and triangles, problem, V, 589; potential of, IX, 266—80; automorphic function for, XI, 169, 179—83, 212—6; partitions of, XIII, 93—113.

**Polyhedra:** Poinot's four new regular solids, IV, 81—5, 86—7, 609; the problem of, IV, 182—5, 609; autopolar, IV, 185; enumeration of, and triangle-faced polyacra, V, 38—40; partitions of close-, V, 62—5, 617; axial properties, V, 529—39; potential of, IX, 266—80.

**Polyhedral Functions** (*see* Hypergeometric Series, Schwarzian Derivative).

**Polyzomal Curves, Memoir on:** VI, 470—576, VII, 115; introductory, VI, 470—2; Part I, polyzomal curves in general, VI, 473—97; definitions and preliminary remarks, VI, 473—4; the branches, VI, 474—6; points common to two branches, VI, 476—8; singularities of a  $\nu$  zomal, VI, 478—9; zomals with common point or points, VI, 479—81; depression of order of  $\nu$  zomal curve from

**PONCELET—POTENZKREIS.**

120

ideal factor of branch or branches, VI, 481—5; the trizomal and tetrazomal, VI, 485; intersection of two  $\nu$  zomals having same zomal curve, VI, 486—7; theorem of decomposition of tetrazomal, VI, 487—9; application to trizomal, VI, 489—94; tetrazomal curve, VI, 494; variable zomal of trizomal curve, resumed, VI, 494—7; Part II, subsidiary investigations, VI, 497—515; preliminary remarks, VI, 497—8; circular points at infinity; rectangular and circular coordinates, VI, 498—9; antipoints; definition and fundamental properties, VI, 499—500; antipoints of circle, VI, 500; antipoints and pair of orthotomic circles, VI, 500; forms of equation of circle, VI, 501; system of 16 points, VI, 501—3; property in regard to four confocal conics, VI, 503—4; system of sixteen points, the axial case, VI, 504—5; involution of four circles, VI, 505—8; locus connected with foregoing, VI, 508—9; formulæ of two sets each of four concyclic points, VI, 509—11; ditto further properties, VI, 512—5; Part III, theory of foci, VI, 515—34; the general theory, VI, 515—7; foci of conics, VI, 517—9; variable zomal applied to conic, VI, 519—21; foci of circular cubic and bicircular quartic, VI, 521—2; centre of circular cubic, and nodo-foci, etc., of bicircular quartic, VI, 522—3; circular cubic and bicircular quartic; symmetrical case, VI, 523; ditto, singular forms, VI, 523—6; analytical theory for circular cubic, VI, 526—8; ditto, for bicircular quartic, VI, 528—30; property that points of contact of tangents from pair of concyclic foci lie in a circle, VI, 530—34; Part IV, trizomal and tetrazomal curves where the zomals are circles, VI, 534—66; the trizomal curve-tangents at  $I$ ,  $J$ , etc., VI, 534—7; foci of conic represented by equation in areal coordinates, VI, 537; theorem of variable zomal, VI, 539—41; relation between conic and circle, VI, 541—2; case of double contact, Casey's equation in problem of tactions, VI, 543; intersections of conic and orthotomic circle on set of four concyclic foci, VI, 543—4; construction of symmetrical curve, VI, 544—6; focal formulæ for general curve, VI, 547; circular cubic, VI, 548—9; focal formulæ for symmetrical curve, VI, 549; symmetrical circular cubic, VI, 549—50; general ditto, VI, 550—3; transformation to new set of concyclic foci, VI, 553; tetrazomal curve, decomposable or indecomposable, VI, 553—4; cases of indecomposable, VI, 554—5; ditto, centres being in line, VI, 555—6; the decomposable curve, VI, 556—7; ditto, centres not in a line, VI, 557—61; ditto, centres in a line, VI, 561—5; ditto, transformation to a different set of concyclic foci, VI, 565—6; theory of Jacobian, VI, 566—8; Casey's theorem for circle touching three given circles, VI, 568—73; a norm when the centres are in line, VI, 573—5; trizomal curves with cusp or two nodes, VI, 575—6.

**Poncelet, J. V.:** harmonic relations, II, 96; porism of in-and-circumscribed triangle, III, 80—5; rectangular hyperbola, III, 254; in-and-circumscribed polygon, V, 21—2; reciprocal polars, XI, 466.

**Pontécoulant, G. de:** *Système du Monde*, III, 309—10; *Lunar Theory*, III, 521, VII, 357.

**Porism:** homographic, defined, III, 74, 84; allographic defined, III, 75, 85; of polygon and correspondence, IX, 94.

**Porism of in-and-circumscribed Polygon:** II, 87—9, 91—2, 97, 138—44, 145—9, IV, 292—308, VIII, 14—21, 212.

**Porism of in-and-circumscribed Triangle:** II, 56, 87—90, 91, III, 67—75, 80—5, 229—41, V, 549—50, 579, VIII, 212—57.

**Portraits of Cayley:** frontispiece to vols. VI, VII, XI.

**Pos:** the abbreviation in groups, XIII, 119.

**Positive:** the rule of signs, IV, 595—6, XI, 492.

**Postulandum of Curve:** the term, I, 583, VII, 140, XII, 501; and capacity, XIII, 115.

**Postulation:** the term, I, 583, VII, 140, 225, VIII, 394; of curve, XII, 501.

**Potential:** and attractions, I, 195.

**Potentials:** of polygons and polyhedra, IX, 266—80; of ellipse and circle, IX, 281—301; Smith's Prize question on, XI, 261—4.

**Potential-solid:** prepotential, IX, 346—7.

**Potential-surface:** prepotential, IX, 343—6.

**Potenzkreis of Steiner:** III, 113.

- Power**: of a matrix, II, 492—4; of homographic function, XI, 253—7.
- Power-enders**: the term, XIII, 267, 270, 295; and reciprocants, XIII, 333.
- Powers**: successive, of homographic function, x, 305—6, 307—9; of roots of algebraical equations, XII, 33—4.
- Precession**: note on theory of, IX, 194—6.
- Prepotentials, Memoir on**: IX, 318—423; introductory, IX, 318—21; prepotential plane, theorem A, IX, 319, 337—43; potential surface, theorem C, IX, 320, 343—6; potential solid, theorem D, IX, 320, 346—7; the prepotential surface integral, IX, 321—30; its continuity, IX, 330—4; potential solid integral, IX, 334—7; examples of foregoing, IX, 347—50; surface and volume of sphere, IX, 351—2; integral, IX, 352—9; prepotentials of uniform spherical shell and solid sphere, IX, 359—79; examples, theorem A, IX, 379—93; Green's integration of prepotential equation, IX, 393—404; examples, theorem C, IX, 404—7; examples, theorem D, IX, 407—8; prepotentials of homaloids, IX, 408—9; Gauss-Jacobi theory of epispheric integrals, IX, 410—7; methods of Lejeune-Dirichlet and Boole, IX, 417—23.
- Prepotentials**: Smith's Prize question, XI, 261.
- Presidential Address**: to British Association, XI, 429—59.
- Prime Numbers**: B.A. report on tables of, IX, 462—70.
- Prime Roots**: tables, IX, 471—7.
- Prn**: the abbreviation for tortuous curves, XIII, 253.
- Principal System of Sextic Curve**: VII, 236—8.
- Principia*: solution of problem, Book I, Sect. V, Lemma xxvii, VII, 30; (*see also* Newton).
- Principiants**: and reciprocants, XIII, 388—98.
- Probabilities**: questions in theory of, II, 103—4, 594—8, v, 80—5, x, 588, 600—1, 614.
- Problems**: mechanical, III, 78—9; a class of dynamical, continuous impact, IV, 7—11; (*see also* Dynamics, Smith's Prize Papers, Three Bodies).
- Problems and Solutions from the Educational Times**: v, 560—612; table of contents, v, 612; VII, 546—607; table of contents, VII, 607—8; x, 566—614; table of contents, x, 615—6; (*see also* Smith's Prize Papers).
- Product**: resolvent, IV, 309—13.
- Product-theorem**: for theta functions, x, 464, 474, 509—46.
- Progress of Theoretical Dynamics** (*see* Dynamics).
- Prohessians**: defined, v, 267; and developables, v, 513—4.
- Prohibitive Points**: in differential equations, XII, 434—41.
- Projectile**: effect of resisting medium, IV, 541.
- Projection**: stereographic, of spherical conic, v, 106—9; of ellipsoid, v, 487—8; plane representation of solid figure, VII, 26—30; stereographic, VII, 397—9, XI, 187—9, 569; blank, VII, 482; of surface on plane, VIII, 538—9; Mercator's, VIII, 567; Mercator's, of skew hyperboloid of revolution, IX, 237—40; a problem of, IX, 508—18; map, XI, 448.
- Prolusions**: Sylvester's Astronomical, XIII, 47.
- Provectant**: defined, II, 514.
- Provector**: defined, II, 514.
- Pseudosphere**: the term, XII, 220.
- Ptolemy**: stereographic projection, XI, 448.
- Puiseux, V.**: algebraic functions, III, 225; spherical pendulum, IV, 533, 591; motion of a body, IV, 583, 591.
- Pyramid** (*see* Polygons, Polyhedra).
- Quadrangle**: in-and-circumscribed, IV, 307—8; differential relation between sides, x, 33—5.
- Quadratic Equation**: roots, v, 160—1; and geometrical interpretation, XI, 258—60.
- Quadratic Form**: composition, I, 532; transformation of, into itself, II, 192—201, 215; tables, v, 141—56, IX, 480—3, 486—93.

**QUADRATIC—QUANTICS.**

122

- Quadratic Residues**: Eisenstein's geometrical proof, III, 39—43.
- Quadratic Transformation of Binary Form**: VIII, 398—400; (*see also* Transformation).
- Quadratics**: resultant of three ternary, and invariant of biternary, IV, 349—58.
- Quadric Cones**: of six given points, V, 4—6; through given points, X, 575.
- Quadric Curves**: V, 70—2.
- Quadric Equations**: transformation of two, I, 428—31, III, 129—31; automorphic linear transformation of, II, 497—505; solution by radicals, X, 9; two related, XI, 37.
- Quadric Integral**: due to Aronhold, XII, 162—9.
- Quadricone**: the term, VI, 334, 585, VII, 264.
- Quadricovariant**: of quantic, II, 520; or Hessian, II, 545; the term, IV, 606.
- Quadrics**: through nine points, I, 425—7; developable from two, I, 486—95; homographic transformation into itself, II, 105—12, 117, 133—7; theorem on surfaces, III, 115—7; equation of differences for, IV, 242; the term, IV, 604; sections of, V, 133—4; through three lines, VII, 177; in hyperdimensional space, IX, 79—83; covariants of, IX, 537—42; envelope of family of, X, 589; correspondence of confocal Cartesians with right line of a hyperboloid, XII, 587—9; (*see also* Binary Quadrics).
- Quadric Seminvariants**: generating functions of, XIII, 306.
- Quadric Surfaces**:  $n$ -dimensional geometry, I, 62; diametral planes of, I, 255—8; centres of similitude, I, 329—31; note, I, 421—2, 589; abstract of memoir by Hesse, I, 425—7; conics inscribed in a, I, 557—63; envelope of certain, VIII, 48—50; inversion, VIII, 67—71; problem, and hypothetical theorems, VIII, 550; and four-dimensional space, IX, 246—9; a system of, X, 269; Jacobian of, X, 568; in *Ency. Brit.*, XI, 576—9, 632; twisted cubics on, XII, 307—10; focals of, XIII, 51—4; reciprocal lines, XIII, 58—9; (*see also* Geodesic Lines).
- Quadric Transformation**: between planes, VII, 213—5, 219—21, XII, 100—1; (*see also* Transformation).
- Quadri-cubic Curves in Space**: V, 16.
- Quadricuspidal**: the word, VII, 51.
- Quadrifactions**: the term, IX, 426.
- Quadrilateral**: and ellipse, V, 604; inscribed in bicircular quartic, X, 231—5; inscribable in circle, X, 578.
- Quadrinvariant**: of binary quartic, first occurrence, I, 93; of quantic, II, 516; the term, IV, 606; of quadriquadric function, XIII, 67—8.
- Quadriquadric**: the term and kinds, V, 10, VII, 99.
- Quadriquadric Curves**: in space, V, 17; on, V, 282; sextic torse for cuspidal edge having, X, 68—72; Abel's theorem, XII, 186—9, 292—8, 321—5; and elliptic functions, XII, 292—8, 321—5.
- Quadriquadric Function**: two invariants of, XIII, 67—8.
- Quadriquadric Transformation**: between spaces, VII, 229—30; (*see also* Transformation).
- Quadrispinal**: the term, VII, 65.
- Quantics, Introductory Memoir**: II, 221—34, 598—601.
- Quantics, Second Memoir**: II, 250—75; numerical tables, II, 276—81.
- Quantics, Third Memoir**: II, 310—35.
- Quantics, Fourth Memoir**: II, 513—26; definitions, II, 513—5; covariants and invariants of degrees, two, three, four, II, 515—20; calculation of discriminant, II, 520—2; the catalecticant, lambdaic, and canonisant, II, 522—3; bezoutiants, cobezoutiants, II, 524—6.
- Quantics, Fifth Memoir**: II, 527—57, 604—6; the single quadric, II, 527—9; two or more, and theories of harmonic relation and involution, II, 529—40; cubics, II, 540—5; quartics, II, 545—56.
- Quantics, Sixth Memoir**: analytical theory of binary and ternary, II, 561—83; general theory of distance, II, 583—92; its style, VIII, xxvii.
- Quantics, Seventh Memoir**: chiefly ternary cubics, IV, 325—41; tables, IV, 333—41.
- Quantics, Eighth Memoir**: VI, 147—90; introductory, IV, 147—8; binary quintic, covariants and syzygies of degree 6, VI, 148—53; formulæ for canonical form, VI, 153—4; 18-thic invariant, VI,



154—6; character of equation, auxiliars, facultative and non-facultative space, VI, 156—8; application to quartic equation, VI, 158—61; characters of quintic equation, VI, 161—5; Tschirnhausen's transformation, VI, 165—9; Hermite's application of Tschirnhausen's transformation to quintic, VI, 170; nodal cubic, VI, 171—4; Hermite's criteria, VI, 174—6; his canonical form of quintic, VI, 177—83; imaginary linear transformations, VI, 183—6; application to auxiliars of quintic, VI, 186—7; theorem of binary quantic, VI, 187—90; the binary quintic and sextic, VI, 190.

**Quantics, Ninth Memoir:** VII, 334—53, IX, 537—42; introductory, VII, 334—5; theory of number of irreducible covariants, VII, 336—7; new formulæ for number of aszygetic covariants, VII, 337—40; the 23 fundamental covariants, VII, 341—8; tables, VII, 341—6; Gordan's proof for the complete system of 23, and concomitants of quintic, VII, 348—53.

**Quantics, Tenth Memoir:** X, 339—400; introductory, X, 339—40; numerical and real generating functions, X, 341—8; table 96, X, 349—55; theory of the canonical form, X, 355—62; table 97, X, 362—9; table 98, X, 370—6; derivatives and tables, X, 377—94; numerical generating functions, N.G.F. of a sextic, X, 394—6; table, X, 397—400.

**Quantics:** defined, II, 221, IV, 594, 604; resultant of, II, 320; discriminants, II, 320; notation of abstract geometry, VI, 464—6; and nilfactum, VI, 466; character of the ten memoirs, VIII, xxx—xxxii; transformable into each other, VIII, 385—7; eliminant of two, XI, 100—2; Sylvester's work in, XIII, 47; syzygetic relations among the powers of linear, XIII, 224—7; and seminvariants, XIII, 363; (*see also* Binary Quantics, Quadratics).

**Quarterly Journal of Pure and Applied Mathematics:** VIII, xii.

**Quartic Curves:** transformation, I, 476—80, 589; special family of, I, 496—9; bitangents of, IV, 342—8, VII, 123—4, X, 244, XI, 221—3, 474; cuspidal defined, V, 10; in space, V, 11—5; and ovals, V, 468—70; triangle in- and circumscribed to a, V, 489—92; with three double points, V, 550, 553; in connexion with cubic and quintic, problem, VI, 580; problem, V, 596; and sextic torse, VII, 99—100; tricuspidal, problem, VII, 589; mechanical description, VIII, 151—5; a penultimate, VIII, 526—8; construction of bicircular, IX, 13—5; and functions of a single parameter, IX, 315—7; with two odd branches, X, 36—7; bicircular, X, 223—42; triple theta functions, X, 446—54; problem and solution, X, 582—6; trinodal, problem, X, 602; singular tangents of, problem, X, 603; degenerate, XI, 220; with cusp at infinity, XI, 408; forms and classification, XI, 480; circular, XI, 481; ground curve in Abel's theorem, XII, 38, 109—216; bitangents of plane-, XII, 74—94; twisted, XII, 428—31; (*see also* Bicircular, Binary, Binodal, and Nodal Quartics).

**Quartic Developables:** and developable surfaces, V, 268—71; reciprocation of, V, 505—10.

**Quartic Equations:** conditions for systems of equal roots, II, 467—8; evolution, II, 547; Tschirnhausen's transformation, IV, 368—74, V, 449; Sturmian constants, IV, 473—7; nodal curve of developable from, V, 135—7; and quantics, VI, 158—61; solution of  $aU+6\beta H=0$ , VII, 128—9; roots, VII, 551, X, 575; solution by radicals, X, 10.

**Quartic Matrix:** Hermite's, XII, 367—72.

**Quartics:** canonical form, II, 548; equation of differences for, IV, 243, 279; the term, IV, 604; roots of, problem, V, 610; conditions for existence of systems of equal roots, VI, 300—12; and three cubics, problem, VII, 546; reality of roots, problem, X, 608.

**Quartic Scroll** (*see* Scrolls).

**Quartic Seminvariants:** XII, 20; generating functions, XIII, 306; and perpetuants, XIII, 316.

**Quartic Surfaces, First Memoir:** VII, 133—81, 609—10; introductory, VII, 133—4; Jacobian surfaces, VII, 134—6; surface by equating to zero a symmetrical determinant, VII, 136—7; surfaces  $F(P, Q)=0$ , etc., VII, 138; nodes of quartic surface, VII, 138—40; number of constants contained in a surface, VII, 140—1; general theory of quartic surface with given nodes, VII, 141—4; Jacobian surface of six given points, VII, 144—5; ditto of seven, or an octad of points, VII, 145—8; the dianodal surface, VII, 148—52; octadic surfaces with 9 or 10 nodes, VII, 152—5; dianomes with 9 or 10 nodes, VII, 155; dianodal curve of 8 points, VII, 155—6; ten nodes, VII, 156; dianodal

**QUARTIC—QUINTICS.**

124

centres of 9 points, VII, 156; result as to dianomes, VII, 156; the symmetroid, (lineo-linear correspondence of quartic surfaces), VII, 157—9; ditto and Jacobian, VII, 160—3; symmetroid with given nodes, VII, 163—6, 259; Jacobian with given lines, VII, 167; correspondence on the Jacobian, VII, 168—70; further investigations as to Jacobian, VII, 171—5; persymmetrical case: Hessian of a cubic, VII, 175; quartics with 11 or more nodes, VII, 176—7; quadric surface through three given lines, VII, 177; condition that five given lines may lie in a cubic surface, VII, 177—8; condition that seven given lines may lie in a quartic, VII, 178; Jacobian of 6 points, VII, 178—9; locus of vertex of quadric cone which touches each of six given lines, VII, 180—1.

**Quartic Surfaces, Second Memoir:** VII, 256—60, 609—10.

**Quartic Surfaces, Third Memoir:** VII, 264—97, 609—10; preliminary considerations and classification, VII, 264—7; sextic curves, VII, 267—71; nodal determination, VII, 271—3; quartic surfaces resumed, VII, 273—4; enumeration of the cases, VII, 274—80; notation for cases afterwards considered, VII, 280—1; 16-nodal surface and table, VII, 281—4; 15-nodal surface and table, VII, 285—8; equation of ditto, VII, 288—9; 14-nodal surface and table, VII, 289—92; 13-nodal surface and table, VII, 293—7.

**Quartic Surfaces:** on, v, 66—9; Steiner, v, 421—3, IX, 1—2; 16-nodal, v, 431—7, VII, 126—7, x, 157—65, 180—3, 604, XII, 95—7; note on, v, 465—7; recent researches, VII, 244—52; Plücker's models, VII, 298—302; some special, VII, 304—13, VIII, 2—11, 25—8; surface and sphere, problem, VII, 589; section of surface, problem, VII, 593; penultimate forms of, VIII, 262—3; symmetrical determinant=0, x, 50—6; 12-nodal, x, 60—2, XIII, 1—2; Hessian of, x, 274—7; tetrahedroid as 16-nodal, x, 437—40; equation of, x, 609; in *Ency. Brit.*, XI, 633—4; (*see also* Cyclide).

**Quartic Syzygy:** and elliptic integrals, II, 191, IV, 68—9, 609.

**Quartic Transformation:** of elliptic functions, IX, 103—6.

**Quartinvariants:** of quartic, II, 516, 520.

**Quartisection:** theory of numbers, XI, 84—96.

**Quasi-inversion:** and orthomorphosis, XIII, 192—3.

**Quasi-minima:** the term, XIII, 42.

**Quasi-normal:** the term, XIII, 228.

**Quaternary:** the term, VI, 464.

**Quaternary Function:** Hessian of, IX, 90—3.

**Quaternions:** certain results, I, 123—6, 127; algebraic couples, I, 128—31; rotation, I, 405—9, 589, v, 537; formulæ of, II, 107; transformation of quadrics, II, 135; skew determinants, II, 214; transformation of coordinates, IV, 559; the equation  $qQ - Qq' = 0$ , XII, 300—4, 311—3; matrices, XII, 303; multiple algebra, XII, 474; hydrodynamical equations, XIII, 8; versus coordinates, XIII, 541—4.

**Quet, J. A.:** relative motion, IV, 536, 592.

**Quetelet, M. A.:** theory of Gergonne, and on caustics, II, 339; wave surface, IV, 433—4.

**Quinisection:** theory of numbers, XI, 314—6, XII, 72—3.

**Quintic Curves:** and developables, I, 500—6; in space, v, 15—6, 20, 24—30, 552, 553, 613; in connexion with cubic and quartic, v, 580.

**Quintic Developables:** and surfaces, v, 272—8, 518.

**Quintic Equations:** conditions for systems of equal roots, II, 468—70; equation of differences, IV, 150—1, 246—61, 276—91; Tschirnhausen's transformation, IV, 375—94; tables, IV, 379—80, 387—90; Jerrard's researches, v, 50—4, 77, 89; character of, VI, 161—5; solvibility by radicals, VII, 13—4, x, 11; theorem of Abel, XI, 132—5; solvable case of, XI, 402—4; and elliptic functions, XIII, 473; their sextic resolvents, XIII, 473—9.

**Quintic Matrix:** XII, 376—80.

**Quintics:** auxiliary equation for, IV, 309—24; Jerrard's form, IV, 392; soluble by elliptic functions,

iv, 484; the term, iv, 604; MacClintock on, iv, 609—16; theorem of Abel as to soluble, v, 55—61, xi, 402—4; discriminant of, problem, v, 592; conditions for existence of systems of equal roots, vi, 300—12; concomitant system of, x, 342; syzygies among covariants of, x, 346—55; canonical form, x, 355—62; resolvent sextic of, xi, 396; bitangents of the, xiii, 21; and seminvariants, xiii, 363—5; (*see also* Binary Quintics).

**Quintic Seminvariants:** and perpetuants, xiii, 309.

**Quintic Surfaces:** and developables, v, 272—8, 518; recent researches, vii, 244—52.

**Quintic Transformation:** of elliptic functions, ix, 122, 148, xii, 522—5.

**Quippian:** the word, ii, 381, 396—7.

**Quotient:**  $G/H$  in theory of groups, xiii, 336—7.

**Raabe, J. L.:** summation of series, ii, 15.

**Radials:** the term, xi, 259, xiii, 179.

**Radicals:** and solvibility of equations, vii, 13—4, x, 8—11; theory of equations, xi, 511—20, 521; Galois and theory of, xi, 543; Weierstrassian cubic transformation, xiii, 31.

**Radicals (Chemical):** number of univalent, ix, 544—5.

**Radii:** the term link- and bar-, vii, 183; curvature of wave-surface, xiii, 248.

**Range:** defined, ii, 577; homography, ii, 578.

**Rank of Seminvariants:** xii, 22.

**Ratio:** and abstract geometry, vi, 457—62.

**Rational Functions:** the term, iv, 603—4.

**Rationalisation:** of algebraic equations, ii, 40—4.

**Rational Transformation** (*see* Transformation, Rational).

**Ray, M. N.:** solution of equations, x, 610—11.

**Ray Planes:** and biaxial crystals, ix, 107—9.

**Rayleigh, Lord:** fluctuating functions, ix, 19—20.

**Rays:** special symmetrical system of three, vii, 428—9; the term, x, 55; systems of, xii, 571—5.

**Real Generating Function:** x, 339.

**Real Intersections of Curves:** ix, 21.

**Reciprocal Figures:** i, 415—20.

**Reciprocal Matrix:** ii, 481.

**Reciprocal Polars:** i, 416, 421; Monge, xi, 465; Poncelet, xi, 466.

**Reciprocals:** of quartic scrolls, vi, 317—27; of cubic surfaces, vi, 368—455; of quartic surfaces, vii, 305; of centro-surface of ellipsoids, viii, 363; equation of conic, viii, 522—3; reciprocal lines, xiii, 58—9.

**Reciprocal Surfaces, Theory of:** vi, 329—58, 577—81, 582—91, 596—601; extension of Salmon's fundamental equations, vi, 329—31; developments, vi, 331—4; new singularities, vi, 334—41; application to a class of surfaces, vi, 341—2; flecnodal curve, vi, 342; surfaces of revolution, in connexion with spinodal and flecnodal curve, vi, 342—4; flecnodal torse, vi, 345; general surface of order  $n$  without singularities, vi, 345—6; formula for  $\beta'$ , vi, 347—53; recapitulation, vi, 353—5; addition, vi, 355—8; Zeuthen, vi, 596—601; theory, xi, 225—34.

**Reciprocants:** of quantic, ii, 320; the term, iv, 607, xiii, 366; and sextactic points, v, 618; of cubic, vi, 73; and invariants, xii, 393; Sylvester on, xiii, 47—8; tables of pure, to weight eight, xiii, 333—5; and differential invariants, xiii, 366—404; Halphen on, xiii, 366, 368—81, 381—98; Cockle, xiii, 366, 367—8; Ampère and Lagrange, xiii, 366; Sylvester, xiii, 366, 379—81, 381—98; MacMahon, xiii, 399—404.

**Reciprocation of Quartic Developable:** v, 505—10.

**Reciprocity:** geometrical, i, 377—82; and quantics, ii, 232, 234; law of, for invariants, ii, 516; and homography, ii, 578.

**RECTANGLE—RIEMANN.**

126

- Rectangle**: potential of, ix, 278—80.
- Rectilinear Motion**: iv, 515—6.
- Reduced Latitude**: vii, 16, ix, 238.
- Reducible Seminvariants**: and perpetuants, xiii, 308—13.
- Reducible Syzygies** (*see* Syzygies).
- Reduction**: of transcendental integrals, x, 214—22.
- Reech, F.**: contour lines, iv, 609.
- Reflection**: caustics by, i, 273—5, ii, 118—22, 129.
- Region**: the term, ix, 331.
- Regular**: the term, vi, 457, 459.
- Regulator**: the term, vii, 402.
- Regulus**: the term, xi, 573, 632.
- Rehorovsky, W.**: symmetric functions, ii, 602.
- Relation**: and abstract geometry, vi, 457—62; omal, vi, 463; parametric, vi, 463—4; a discriminant, vi, 467; Jacobian, vi, 467.
- Relink**: the term, v, 521.
- Remblais**: theory of, xi, 417—20, 449, 587.
- Reports**: on progress of theoretical dynamics, iii, 156—204; on progress in solution of certain problems in dynamics, iv, 513—93; on Pellian equation, xiii, 430—67.
- Representation**: analytical, of curves in space, iv, 446—55, 490—5, xi, 83; of solid figure in plane, vii, 26—30; of surfaces on a plane, viii, 538; of variables by correspondence of planes, x, 316—23; conformal, xi, 78—81; graphical, of binodal quartic and the elliptic functions, xiii, 9—19; Sylvester on graphical, xiii, 47; (*see also* Orthomorphosis, Transformation).
- Réseau**: the term, vii, 253.
- Residuation**: of cubic curve, ix, 211—4, xii, 115—6; of curves, xii, 502; Sylvester's theory of, xiii, 47.
- Residues**: Cauchy's theorem on, i, 148, 174; Eisenstein's geometrical proof of quadratic, iii, 39—43; nodal, of scrolls, v, 169—70, 181—3, 184, 187.
- Resisting Medium**: motion in, iv, 541.
- Resolvent Equations**: sextic, of Jacobi and Kronecker, xiii, 473—9.
- Resolvents**: after Lagrange, iv, 309; of quintics, xi, 396.
- Resultant**: the term, i, 63, 337, iv, 597, 602—3, vi, 466—7; of quantics, ii, 320; of two equations, ii, 440—53, vi, 292—9; of two binary quantics, iv, 1—4, ix, 16—7; of three ternary quadratics, iv, 349—58; of two binary cubics, v, 289; of forces, x, 589.
- Resultor**: defined, ii, 59.
- Reversion**: of series, iv, 30—7, 54—9.
- Reuschle, K. G.**: mathematical tables, ix, 468—9, 473, 485, 494—9, xi, 95—6; theory of numbers, xi, 85—6, 315, 612.
- Rhamphoid Cusp**: v, 265—6, 618.
- Rhizic Theory**: root-limitation, ix, 34—8.
- Ribaucour, C. R.**: orthogonal surfaces, viii, 569—70.
- Riccati, J. F.**: solution of equation, vii, 9—12.
- Richelot, F. J.**: Abelian integrals, i, 366, 367; solution of equation  $x^{267} - 1 = 0$ , i, 564; porism formula, ii, 90; in-and-circumscribed triangle, iii, 237—41; spherical pendulum, iv, 534, 592; rotation of solid body, iv, 577—8, 592; rotation round fixed point, iv, 583, 592; two quartic curves, x, 584; integral of Euler's differential equation, xiii, 525—9.
- Richmond, H. W.**: Pascal's theorem, vi, 594.
- Riemann, G. F. B.**: doubly infinite series, ii, 593; genus of curve, v, 476—7, 517; Abelian integrals, v, 521, xi, 30; Abelian functions, vi, 2, 264, 593; elliptic geometry, viii, xxxvii; transformation and theory of invariants, viii, 387; surface of, and correspondence, x, 317, 323; bitangents of

quartic, XI, 221—3; fractional differentiation, XI, 235—6; notion of space, XI, 435—7; correspondence of points, XI, 440; deficiency of curves, XI, 450; hyperelliptic functions, XI, 454—5; transformation, XI, 482; elliptic functions, XI, 534, 537, 539, 546; theory of numbers, XI, 616; series, XI, 627; minimal surface, XI, 639; Abelian functions and plane quartics, XII, 74, 87, 95; linear differential equations, XII, 396; orthomorphosis, XIII, 180, 189, 204.

**Right-handed Root-limitation:** IX, 22—3.

**Roberts, C. A.:** Pellian equation, XIII, 467.

**Roberts, M.:** geodesic lines on ellipsoid, VII, 34.

**Roberts, S.:** description of nodal bicircular quartic, VII, 182—8; points on cubic curve, VII, 549; three-bar curve, IX, 551; symmetrical determinant, X, 579—80; theorems of squares, XI, 294; curves, XI, 481; kinematics of a plane, XIII, 505.

**Roberts, W.:** transformations of curves, I, 471—5, 478; surface parallel to ellipsoid, IV, 158—65.

**Roberts, W. R. W.:** cyclyde, IX, 75.

**Rodrigues, O.:** motion of solid body, I, 28—35, 124, 405, 583; quaternions, I, 124, 586; rotation of solid body, I, 237; skew determinants, I, 335; expansions in multiple sines, I, 583; attraction of ellipsoids, III, 149—53; transformation of coordinates, IV, 558, 559, 592, XI, 575; kinematics of solid body, IV, 581, 592; on rotation formulæ, V, 537; correspondence of homographies and rotations, X, 153.

**Rohn, K.:** quartic surfaces, VII, 609—10; quartic surface with twelve nodes, XIII, 2.

**Roof:** the term in non-Euclidian geometry, XIII, 484.

**Root-limitation:** geometrical representation, IX, 21—39; general theory, IX, 22—7; intercalation theory for right line, IX, 28—33; rhizic theory, IX, 34—8.

**Roots:** in forms called trees, III, 243, XI, 365—7; of algebraic equations, IV, 116—9, XI, 506—21, XII, 33—4, XIII, 33—7; quadratic equations, V, 160—1; of equations, Cauchy's theorem, IX, 21—39; of unity, IX, 263; of quartic, reality of, X, 608; imaginary, of equations, XI, 114—21, 502—6; equal, of equations, XI, 405—7; theory of real equations, XI, 497—502; Sylvester's work at, XIII, 46; ninth, of unity, XIII, 66; Waring's formula for sum of  $m$ th powers of, of an equation, XIII, 213—6; of a quantic, symmetric functions of, XIII, 271—85.

**Roots of Unity:** prime, XI, 56—60.

**Rosenhain, J. G.:** theta functions, VIII, xlii, X, 464, 499; double theta functions and 16-nodal quartic surface, X, 158, 162; theory of numbers, XI, 60; double theta functions, XI, 454.

**Rotation:** of solid body, I, 28—35, 237, 583, II, 107, III, 475—504, IV, 566—80, 592; quaternions and theory of, I, 405—9, 589; formula of, I, 586; and elliptic motion, III, 475; of earth, III, 485; infinitesimal, V, 498—9, VI, 24—6; of group of polyhedra, V, 529, 559; Euler's memoir of 1758, VI, 135—46; equilibrium of, VII, 91—5; and homography, X, 153—4; in conformal representation, XI, 78.

**Roulette:** the term, XI, 447.

**Route:** the term, XII, 640.

**Rowe, R. C.:** memoir on Abel's theorem, XI, 29—36; partitions of a polygon, XIII, 93, 112.

**Royal Society:** Cayley elected a fellow in 1852, VIII, xiii; Croonian lecture founded, VIII, xv; medals bestowed on Cayley, VIII, xxi.

**Rudio, F.:** inverse centro-surfaces, XII, 457—8.

**Rueb, A. S.:** motion of solid body, I, 464; spherical pendulum, IV, 534; rotation of solid body, IV, 573—4, 592.

**Rule of Signs:** and determinants, XI, 492.

**Sabine, Sir E.:** death of, XI, 429—30.

**Sadleir, Lady Mary:** endowments by, VIII, xv.

**Sadlerian Professorship:** Cayley appointed to, VIII, xvi.

## SAFFORD—SCHWARZIAN.

128

**Safford, T. H.** : orbits of Neptune and Uranus, ix, 183.**St Laurent, M.** : on caustics, ii, 118, 121, 122, 347, 355, 368.

**Salmon, G.** : cubic surfaces and triple tangents, i, 446, 456, 589; linear transformations and elimination, i, 457—61; singular contact, i, 486; curves and developables, i, 492, 587; developable from quintic curve, i, 500—1, 505; systems of equations, i, 533; geometry of position, i, 555; hyperdeterminants, i, 579, ii, 598—601; on a plane touching a surface, ii, 29; triple tangent planes of third order, ii, 29; invariant of ternary cubic, ii, 325; quippian, ii, 381; tables of covariants, ii, 536—7; binary quartics, ii, 549; tangential of cubic, ii, 558; equation of orthotomic circle, iii, 48—50; reciprocal surfaces, iv, 21—7, vi, 329—58, 359, 582—91; surface parallel to ellipsoid, iv, 158—65; double tangents, iv, 187—206, 343, xi, 473—4; cubic curves, iv, 188; conics and five-pointic contact, iv, 207—39; higher algebra, iv, 608; curves in space, v, 9—20, 614; quartic surfaces, v, 66, vii, 136; cubic surfaces, v, 140, vi, 359; scrolls, v, 168—9, 193, 200; prohessian, v, 267; involution, v, 301; higher singularities of plane curves, v, 620; plane curves, vi, 2; invariants, vi, 108; quintics, vi, 154; hyperspace, vi, 191; elimination, and curves which satisfy given conditions, vi, 192; extension of his fundamental equations, vi, 329—31; polyzomal curves, vi, 472, 531, 560; tetrahedral scrolls, vii, 52, 65; sextic torse, vii, 113, 114; centro-surface of ellipsoid, vii, 130, viii, 316, 320, 323; rational transformation between two spaces, vii, 226, 237; bicircular quartic, vii, 575; locus *in plano*, vii, 606; correspondence with Cayley, viii, xv; on Cayley, viii, xxv; evolutes and parallel curves, viii, 33; theory of curve and torse, viii, 72, 76—9, 87—91; theory of invariants, viii, 386; transformation of unicursal surfaces, viii, 390, 391; residuation, ix, 211; triple theta functions, x, 444; tortuous curves, xi, 9; higher plane curves, xi, 217; Gaussian theory of surfaces, xi, 332; concomitants of ternary cubic, xi, 342; tables for binary sextic, xi, 377; Jacobian sextic equation, xi, 390, 400; equal roots of equations, xi, 407; works on geometry, xi, 546; minimal surfaces, xi, 639; bitangents of quintics, xiii, 21; wave surfaces, xiii, 252.

**Satellite Line** : ii, 383, v, 359.**Scalars and Quaternions** : xiii, 541.**Scalene Transformation of Plane Curve** : ix, 527—34.**Schellbach, C. H.** : solution of Malfatti's problem, iii, 44—7.

**Schläfli, L.** : discriminants, i, 584; elimination, ii, 181—4, 404; symmetric functions, ii, 454; hyperdeterminants, ii, 598—601; resultants, iv, 2—4; numerical expansions, iv, 471; cubic surfaces, vi, 359, 361, 362, 372, vii, 250; quartic surfaces, vii, 308; modular equation for cubic transformation, xiii, 64—5.

**Schlömilch, O.** : attractions, i, 288; a definite integral, iv, 29.**Schoolgirl Problem** : i, 483, 589, v, 95—7.**Schottky, F.** : theta functions, xi, 242—9.**Schröter, H.** : Steiner's quartic surface, v, 423; construction of regular pentagon, xii, 47.**Schubert, H.** : elliptic motion, iii, 473, 474, iv, 523; *abzählende Geometrie*, xi, 281—93, 459.

**Schwarz, H. A.** : inverse elliptic functions, i, 586; developable surfaces, v, 517—9; deficiency, vi, 2; scrolls, vi, 312; quintic scrolls, vii, 250, 252; projections, ix, 508; surface of minimum area, x, 63; hypergeometric series, xi, 125; orthomorphosis, xii, 328, xiii, 188, 191, 192, 193, 202; Kummer's differential equation, xiii, 69.

**Schwarzian Derivative and Polyhedral Functions, Memoir** : xi, 148—216; introductory, xi, 148—51; Part I, xi, 151—79; the derivative, xi, 151—3; quadric function of three or more inverts, xi, 153—6; functions  $P, Q, R$ , xi, 156—7; table ditto, xi, 158—9; differential equations involving  $(x, z)$  and  $(s, x)$ , xi, 160—9; Schwarzian theory, xi, 169—76; connexion with differential equation for hypergeometric series, xi, 176—9; Part II, the polyhedral functions, xi, 179—216; origin and properties, xi, 179—83; covariantive formulæ, xi, 184—5; the forms of  $f^5$  and  $h^5$ , xi, 185—6; stereographic projection, xi, 187—9; groups of homographic transformations, xi, 189—90, 196—208; the regular

- polyhedra, XI, 190—5; system of fifteen circles, XI, 208—12; regular polyhedra as solid figures, XI, 212—6.
- Schwarzian Derivative, and Polyhedral Functions:** XI, 149, 173, 177; and Kummer's differential equation, XIII, 69; and reciprocants, XIII, 366.
- Schwarzian Function:** Sylvester on the, XIII, 381.
- Scientific Memoirs Catalogue:** report on, v, 546—8, 620.
- Scrolar:** the term, VI, 334.
- Scrolls, First Memoir:** v, 168—200.
- Scrolls, Second Memoir:** v, 201—20, VI, 360; degeneracy, v, 201—3; with two directrix lines, v, 203—5; twofold directrix line, v, 205—7; scroll equations, v, 207—10; cubic scrolls, v, 210—3; quartic scrolls, v, 214—9; general theory, v, 219—20.
- Scrolls, Third Memoir:** VI, 312—28; quartic scrolls, VI, 312—4, 314—7, 328; reciprocals, VI, 317—25, 325—7.
- Scrolls:** cubic, v, 90—4, 110—2; quartic, VI, 451; tetrahedral, VII, 48—53; on certain, VII, 54—65; recent researches, VII, 250—1; and octic surfaces, x, 79—92; flexure and equilibrium, XI, 317—22; the term, XI, 573; applicable upon a given skew surface, XIII, 231—7.
- Secondary Caustics** (*see* Caustics).
- Secular Acceleration of Moon's Mean Motion:** III, 522—561.
- Seeber, L.:** mathematical tables, IX, 491—2.
- Segar, H. W.:** development of  $(1+n^2x)^{m/n}$ , XIII, 354—6.
- Segner, J. A. v.:** inertia, IV, 561—2, 592.
- Segregates:** the term, x, 339, 345; table of, x, 349—55.
- Semi-cubical Parabola:** and Abel's theorem, XII, 180—6.
- Seminvariants, memoir:** XII, 239—62; introductory, XII, 239—40; multiplication of two symmetric functions, XII, 240—8; capitulation and decapitation, XII, 248—50; perpetuants, etc., XII, 250—7; sextic perpetuants and sextic syzygies, syzygants, XII, 257—62.
- Seminvariants:** the term, IV, 241, 606; theory of, XII, 22—9, 344—57, XIII, 362—5; tables, XII, 275—89, XIII, 217—23; theorem relating to, XII, 326—7; (*see also* Covariants, Invariants).
- Seminvariants and Symmetric Functions, Memoir:** XIII, 265—332; introductory, XIII, 265—6; the coefficients  $(a, b, c, \dots)$ , XIII, 266—71; symmetric functions of the roots, XIII, 271—85; MacMahon form of equation, XIII, 286—8; the *I-and-F* problem, and solution by square diagrams, XIII, 288—98; MacMahon linkage, XIII, 298—301; umbral notation, Stroh's theory, XIII, 301—6; symmetric functions of a given degree: generating functions, XIII, 306—8; reducible seminvariants—perpetuants, XIII, 308—13; Strohian theory resumed: application to perpetuants, XIII, 314—8; investigation of the values of the foregoing functions, XIII,  $\Pi_{10}(x+y)$   $\Pi_{15}(x+y)$  and  $\Pi_{10}(x+y+z)$ , XIII, 318—21; the operators, XIII, 322—32.
- Senate House Problems:** IX, 246—9, XI, 265—7, XIII, 538—40; (*see also* Smith's Prize Papers).
- Separations of Partitions:** II, 603; (*see also* Partitions).
- Separator:** the term, VII, 402.
- Septic, Binary:** generating functions of, x, 408—21.
- Septic Transformation in Elliptic Functions:** IX, 148—52, x, 333—8.
- Series:** a double infinite, II, 8—10, 593; sums of, III, 124—8, XIII, 49—50; reversion, IV, 30—7; formula for reversion, IV, 54—9; in integration of differential equations, VIII, 458—62; hypergeometric, XI, 17—25, 125—7; in *Ency. Brit.*, XI, 617—27 (finite, XI, 617—20; infinite, XI, 620—7).
- Serpuloid Curve:** IV, 571—2.
- Serret, J. A.:** attractions, I, 288; integral calculus, I, 313; elliptic functions, III, 3; integration of differential equations, III, 185—6, 203; problem of two centres, IV, 528, 531, 592; theory of substitutions, VII, 47; curves of curvature, VII, 331, XII, 601—38; orthogonal surfaces, VIII, 279, 292; indefinite integration, IX, 500—3; transformation of cubic function, XI, 411; minimal surfaces, XII, 595.

**SERRET—SIXTEEN.**

130

- Serret, P.:** syzygetic relations, XIII, 224.
- Servois, J. F.:** multiple algebra, XII, 468.
- Sets:** homology of, III, 35.
- Sextactic Points:** and plane curves, v, 545, VI, 217; and reciprocants, v, 618.
- Sextactic Reciprocant:** XIII, 387.
- Sextic:** binary, and quintics, VI, 190; unicursal, VI, 248; and cubic curves in pencil of six lines, VI, 593—4; the anharmonic-ratio, VII, 314—5; bicursal, IX, 551, 581—6; tricircular, IX, 562—70; numerical generating function, x, 394—6.
- Sextic Cone:** circumscribed to quartic surface, VII, 265; and nodes, table, VII, 291.
- Sextic Curves:** foci of conics, VII, 1—4; rational transformation, VII, 236—8; and nodes, VII, 256—7; and quartic surfaces, VII, 267—71; mechanical description, VIII, 138—44; with five double points, IX, 504—7.
- Sextic Developable:** v, 279—83, 511—9, VI, 87—100.
- Sextic Function:** and Abelian functions, XI, 483.
- Sextic Resolvent:** Jacobian, IV, 310, XI, 389—401, XII, 493—9.
- Sextic Resolvent Equations:** of Jacobi and Kronecker, XIII, 473—9.
- Sextic Seminvariants:** and perpetuants, XIII, 317.
- Sextic, Spherical:** and oval, v, 469.
- Sextic Syzygies:** XII, 257—62, 273.
- Sextic Torse** (*see* Torse, on a certain Sextic, *also* Torses).
- Shanks, W.:** log 2, XI, 70.
- Sharp:** the term, VIII, 406—8, XIII, 265, 291, 304—6, 362.
- Sharp-cone:** the term, VIII, 102.
- Sheets:** roots in algebraic equations, IV, 116—9; cubic curves, IV, 120—2.
- Shell:** formulæ for potential of, IX, 266—7; attraction of ellipsoidal, on exterior point, IX, 302—11.
- Sibi-reciprocal Surfaces:** VI, 21, x, 252—5.
- Siebeck, F. H.:** binodal quartic and graphical representation of the elliptic functions, XIII, 10.
- Signs:** rule of, IV, 595—6, XI, 492.
- Sign Symbols:** theorems, VIII, 535—7.
- Simple Cone:** defined, v, 402, 404, 551.
- Simple Groups:** XIII, 533.
- Simultaneous Equations:** Jacobi's theorem in, XII, 39.
- Simultaneous Roots of Two Equations:** Jacobi's theorem in, XII, 123—5.
- Sines, Multiple:** x, 1—2.
- Single Theta Functions:** memoir, x, 473, 476—97; and double theta functions, x, 155—6, 186—9; and elliptic functions, XI, 250—1; linear transformation, XII, 50—5.
- Singular Curve:** on surface, VII, 244.
- Singularities:** of curves and developables, I, 208; of tortuous curves, I, 500; of surfaces, II, 28—32, IV, 21—7, VI, 123—8, 334—41, 354, 582—5, VIII, 394—8, XI, 225—6, 630—1; of plane curves, v, 424—6, 476—7, 520—8, 619, VI, 3, XI, 30—6; of curves and torses, v, 516; compound, v, 525; of curves in space, v, 613; of cubic surfaces, VI, 363; reciprocal surfaces, VI, 596—601; of curves, XI, 486—70.
- Singular Point:** for differential equations, XII, 395; integrals in domain of, XII, 395—402.
- Singular Solutions of Differential Equations:** IV, 426—7; of first order, VIII, 529—34, x, 19—24.
- Six Coordinates of a Line** (*see* Coordinates, Six of a Line).
- Six Lines:** Sylvester's involution of, VII, 66.
- Six-pointic Contact:** on cubic, IV, 207.
- Sixteen-nodal Quartic Surfaces:** I, 587, v, 431—7, VI, 126—7, 281—4, x, 157—65, 180—3, 437—40, 464, 548—51, 604, XII, 95—7.



- Skew**: the word, I, 332.
- Skew Antipoint**: the term, IX, 65—6.
- Skew Convertible Matrices**: II, 489.
- Skew Covariants**: II, 233.
- Skew Cubics**: demonstration of Chasles' theorem, I, 212.
- Skew Curvature**: the term, I, 234.
- Skew Determinants**: the term, and some properties of, I, 332—6, 410; on, I, 410—3, 589; researches, II, 202—15, IV, 72—3; and transformation, II, 497; a theorem, IV, 72—3.
- Skew Hyperboloids**: geodesic lines, VIII, 174—8, 188—99; of revolution, projection of, IX, 237—40.
- Skew Matrix**: IV, 602.
- Skew Polars**: I, 378.
- Skew Reciprocals**: the term, I, 415.
- Skew Surfaces** (*see* Scrolls).
- Slope Lines**: IV, 108—11, 609.
- Smith, H. J. S.**: higher singularities of plane curves, V, 619; transformation of elliptic functions, IX, 174—5; report on mathematical tables, IX, 461—99; death of, XI, 429; theory of numbers, XI, 612; theta and omega functions, XII, 50; theta functions, XII, 337; transformation, XIII, 38; predecessor of Sylvester in Oxford chair, XIII, 44; on a memoir by, XIII, 558—9.
- Smith, P.**: on Lagrange's solution of caustic, II, 353.
- Smith's Prize Papers**: VIII, 414—35, 436—8, 439—57, 474—90, 496—516, 538—9, 551—5, 558—63; infinitesimal rotation, VI, 24—6; general equation for virtual velocities, IX, 205—8; solutions and remarks, IX, 218—36; Bernoulli's numbers in analysis, IX, 259—62; problems and solutions 1877, X, 39—46; question on theory of equations, XI, 115; on potentials, XI, 261—4.
- Sohnke, L. A.**: motion in resisting medium, IV, 541; transformation of elliptic functions, IX, 113, 114; ditto table, IX, 128—35; modular equations, IX, 543.
- Solar Eclipse, Graphical Construction**: VII, 390—1, 479—92; geometrical theory, VII, 392—6, X, 310—5; general explanation, VII, 479—82; modification for single blank projection, VII, 482—4; construction of relative orbits, VII, 484—7; geometrical theory of projection of penumbral curve, VII, 488—9; details and application to eclipse 21—22/12/70, VII, 489—92.
- Solid Body**: motion of, I, 28—35, 583; geometrical representation of motion, I, 234—6; rotation round fixed point, I, 237—52, 336; rotation of, I, 462—4, III, 475—504, IV, 577, 592; four forces acting on, IX, 201.
- Solid Integral Prepotential**: IX, 334—7.
- Solid of Revolution**: attraction of, I, 508.
- Solids**: Poinot's four new regular, IV, 81—5, 86—7; plane representation of, VII, 26—30.
- Soluble Quintics**: IV, 484, V, 55—61, XI, 402—4.
- Solutions** (*see* Problems, Problems and Solutions, Smith's Prize Papers).
- Somoff, J.**: rotation of solid body, IV, 577, 592.
- Space**: of any number of dimensions, and quantics, II, 222; facultative and non-facultative, VI, 156; dimensions and abstract geometry, VI, 456—7; rational transformation, VII, 189—240; multiple, VIII, xxxiii—v; points and lines, correspondence in, VIII, 566; flexure, X, 331—2; the term in five-dimensional geometry, IX, 79; theories of, XI, 434—7; curves in, XI, 489; elliptic, and non-Euclidian geometry, XIII, 481; (*see also* Hyperspace).
- Special Conditions for Curves**: VI, 193.
- Species**: of Quartic Scrolls, V, 201, VI, 328; twenty-three, of cubic surfaces, VI, 359—60.
- Specific**: the term, XIII, 290.
- Sphere**: powers of, I, 581; and polyhedron, V, 531; problem and solution, VII, 563; prepotentials, IX, 351—2, 359—79; in *Ency. Brit.*, XI, 571—2.
- Spherical Conics**: theorem, IV, 428; stereographic projection, V, 106—9; (*see also* Polyzomal Curves).

**SPHERICAL—STRICTION.**

132

**Spherical Curves of Curvature**: surfaces with, XII, 601—38.**Spherical Pendulum**: IV, 532—4, 535—7, 541.**Spherical Triangle**: theorem of, IV, 80; nine-point circle of, XIII, 548—51.**Spherogram**: the term, VII, 404; and isoperimetric lines, VII, 467—8;  $e$ - and iseccentric lines, VII, 468—70; time- and isochronic lines, VII, 470—7; two plates, VII, to face 478.**Spheroidal Trigonometry**: IX, 197.**Spheroid, Oblate**: geodesic lines on, VII, 15—25.**Spheroquartic**: the term, VIII, 262.**Spinodal Curve**: VI, 342—4, 583—5.**Spinode**: synonymous with cusp, II, 28, IV, 22, 27; the term, V, 521; plane and torse, VI, 355, 583—5, 601.**Spinode Curves**: and cubic surfaces, VI, 450, 595.**Spottiswoode, W.**: ineunts, IV, 419; determinants, IV, 608; text-book on determinants, IV, 608; intersection of line and conic, V, 500—4; twenty-one coordinates of conic in space, XI, 82—3; death of, XI, 430; Sylvester's researches, XIII, 44.**Square Diagrams**: seminvariants and solution by, XIII, 288—98.**Squares**: products of sums of, II, 49—52; surfaces divisible by curves of curvature into, VIII, 97—8, 145—6, 264—8; theorems of 2-, 4-, 8-, 16-, XI, 294—313; imaginaries of 8-, XI, 368—71; Mill on, XI, 432—3; Latin-, XIII, 55—7; orthomorphosis of, into circles, XIII, 191—202.**Squares of Roots**: equations of, IV, 242—3.**Squarewise Contractible**: the term, XIII, 179.**Stader, F.**: central forces problem, IV, 520, 592.**Standard Solutions**: of system of linear equations, XII, 19—21.**Statics**: six coordinates of a line, VII, 89—95; and time, XI, 444; and Archimedes, XI, 446.**Stativity**: the term, VIII, 213.**Staudt, K. G. C. v.**: distances of points, I, 581; theory of distance, II, 605; theorem of, on Bernoulli's numbers, IX, 261.**Steiner, J.**: Pascal's theorem, I, 322—8; geometry of position, I, 356, 550—6; transformation of curves, I, 474; conics inscribed in a quadric surface, I, 557; cubic surfaces and triple tangent planes, I, 589; extension of Malfatti's problem, II, 57—86, 593; porism formula, II, 90; harmonic relation of two lines or points, II, 96; in-and-circumscribed polygon, II, 141; problems on quadrics, II, 179—80; pippian, II, 381, 391; systems of circles, III, 113; double tangents, IV, 187; conics, IV, 207; point of six-pointic contact on cubic, IV, 207; conics touching curves, V, 31—2; generalized theorem, V, 100—2; pedals, V, 113; quartic surface, V, 421—3; theorem of eight points on a conic, V, 427—30; Casey's equation, VI, 67; locus, envelope, and triangle, VI, 72; bitangents of quartic curve, VII, 124; quartic surface of, VII, 247, VIII, 389, IX, 1—2, X, 607; attraction of ellipsoidal shell, IX, 302.**Stellated Polyhedra**: IV, 82, 609.**Stereographic Projection**: of spherical conic, V, 106—9; geodesic lines on oblate spheroid, VII, 24—5; property of, VII, 397—9, XI, 187—9, 569.**Stereoscope**: and cubic curves, IV, 122.**Stern, M. A.**: sums of certain series, III, 126.**Stirling, J.**: curve classification, V, 354; proof of his theorem, X, 267—8.**Stockwell, J. N.**: determinants, V, 45—9.**Stokes, Sir G. G.**: surfaces, envelopes, and parallel curves, IV, 123—33; resisting medium, IV, 541; Catalogue of Scientific Memoirs, V, 546—8, 620; report on mathematical tables, IX, 461—99.**Streblosis**: XI, 79, 81.**Striction, Curve of**: the term, I, 234.**Striction, Lines of**: on skew surfaces, XIII, 232—7.

**Stroh, E:** perpetuants, XIII, 266, 301—6, 314—8.

**Study, E:** Zeuthen on, VI, 594.

**Sturm, J. C. F.:** integration of dynamical equations, III, 186, 203.

**Sturm, R.:** homography, VIII, 200; correspondence of points and tetrahedra, VIII, 200—8; root-limitation, IX, 39; theory of equations, X, 4—5, XI, 498—9, 505.

**Sturmian Constants:** for cubic and quartic equations, IV, 473—7; for quantics, VI, 159.

**Sturmian Functions:** note on, I, 306—8, 588; new researches, I, 392—6; endoscopic and exoscopic expressions, I, 588; tables for equations from second to fifth degrees, II, 471—4.

**Sturm's Theorem:** VI, 159, 161; Sylvester's work at, XIII, 46.

**Subinvariants:** the term, XII, 251, 273.

**Subrational:** the term, IX, 315.

**Sub-regular Integrals:** of differential equations, XII, 444—52.

**Substitutions:** theorem relative to theory, VII, 47; arising from a problem in arrangements, X, 247—8; and theory of groups, X, 324—30, 401—6; and permutations, X, 574; evolution, XI, 455; the notion of, XI, 509—10, 521; Latin squares, XIII, 55—7; groups for two to eight letters, XIII, 117—49; Sylow's theorems on groups, XIII, 530—3; sixty icosahedral, XIII, 552—7.

**Subsurface:** the term, IX, 79.

**Summit:** defined, V, 63, XIII, 507.

**Sums:** of squares, II, 49—52; the term, X, 186, 192; of two series, XIII, 49—50.

**Sun:** and moon's mean motion, III, 522—61; Newcomb on parallax, IX, 177—8; (*see also* Solar Eclipse).

**Supercurve:** the term, IX, 79.

**Superlines:** in hyperspace, IX, 79—83.

**Supp:** the term, VI, 263.

**Supplement:** the term, VI, 263.

**Surement-de-Missery, A.:** imaginaries, XII, 467.

**Surface, Congruence, Complex, in *Ency. Brit.*:** XI, 628—39; introductory, XI, 628—9; surfaces in general: torsos, XI, 629—32; surfaces of orders 2, 3, and 4, XI, 632—4; congruences and complexes, XI, 634—5; curves of curvature: asymptotic lines, XI, 635—6; geodesic lines, XI, 636—7; curvilinear coordinates, XI, 637; orthotomic surfaces: parallel surfaces, XI, 637—8; minimal surface, XI, 638—9.

**Surface-integral:** prepotential, IX, 321—30.

**Surface of Centres:** for wave-surface, XIII, 248; (*see also* Ellipsoid, Centro-surface of).

**Surface of Cylinder:** Archimedes' theorem for, XII, 56—7.

**Surface of Revolution:** and Mercator's projection, VIII, 567.

**Surfaces:** equimomental, I, 253—4; wave (tetrahedroid), I, 302—5, 587; confocal, I, 362—3; singularities, II, 28—32, IV, 22—7; theory of skew, II, 33—4; envelopes and parallel curves, IV, 123—33, 152—7, 158—65; curvature of, IV, 466—9; theorem on degenerate, V, 98—9; developable, and proffessions, V, 267—83; planar, V, 578; sibi-reciprocal, VI, 21, X, 252—5; sextic, VI, 87—100; singularity of, VI, 123—8; tetrahedral, VII, 48—53; on certain skew, VII, 54—65; Steiner's, VII, 247; intersection of two, VII, 563; divisible into squares by curves of curvature, VIII, 97—8, 145—6, 264—8; correspondence, transformation, and deficiency, VIII, 200—8; penultimate forms of, VIII, 262—3; transformation of unicursal, VIII, 388—93; deficiency of certain, VIII, 394—7; reciprocal, VIII, 394; of eighth order, VIII, 401—3; representation on plane, VIII, 538—9; families of, VIII, 567; transformation of equation of, to chief axes, IX, 48—51; the term, in five-dimensional geometry, IX, 79; orthogonal to set of lines, IX, 587—91; flexure of spherical, X, 30—2; of minimum area, X, 63—7, XIII, 41—2; octic, X, 79—92; on a sibi-reciprocal (octic), X, 252—5; flefnodal planes, X, 262—4; Jacobian of six points, X, 281—93; flexure of, X, 331—2; distribution of electricity on two spherical, XI, 1—6; general theory, XI, 14—6, 224; deformation and flexure of, XI, 66—7, 317—22; theory of apsidal, XI, 111—3; theory of reciprocal, XI, 225—34; contact of line with, XI, 281—93; geodesic curvature of

**SWITZERLAND—SYMMETRIC.**

134

curve on a, XI, 323—30; Gaussian theory, XI, 331—6; and solid geometry, XI, 569; ruled, in *Ency. Brit.*, XI, 572—3; in *Ency. Brit.*, XI, 580—2; general theory of curvilinear coordinates, XII, 1—18; determination of order of surface, XII, 42—4; minimal, and Joachimsthal's theorem, XII, 594—5; with plane or spherical curves of curvature, XII, 601—38; quasi-minimal, XIII, 42; the absolute, XIII, 42; applicable to each other, XIII, 253—64; and systems of tetrads of circles, XIII, 425—9; of order  $n$  which pass through given cubic curve, XIII, 534—5; (*see also* Developables, Monoid, Orthogonal, Parallel, Reciprocal, and Wave Surfaces, Scrolls).

**Switzerland**: Cayley's visits to, VIII, xi.

**Syllogism**: theory of, VIII, 65—6.

**Sylow, L.**: theorems on groups, XIII, 530—3.

**Sylvester, J. J.**: special factors, I, 337; Sturmian functions, I, 392, II, 471—4; schoolgirl problem, I, 483; theory of hyperdeterminants, I, 577, 589; commutants, I, 584; endoscopic, I, 588; theory of permutants, II, 23, 26, 27; rationalization of algebraical equations, II, 42; matrices, II, 219, 604; law of reciprocity, II, 232, 234; partitions, II, 248—9, 506, XII, 217; contravariants, II, 320; combinants, II, 322; cubic curves, II, 405; symmetric functions, II, 465; canonical forms, II, 523; cobezoutiants, II, 524; bezoutiants, II, 526; hyperdeterminants, II, 598—601; logic of characteristics, III, 52; a special determinant, III, 122; elimination, III, 214—5; independent variables in differential calculus, III, 246; reversion of series, IV, 36, 37, 54—9; canonical form of binary quantics, IV, 43—52, 53; double partitions, IV, 166—70; conics and five-pointic contact, IV, 231; on derivative of point on cubic, IV, 231; finite differences, IV, 263; equation of differences, IV, 277; invariants, IV, 349; Tschirnhausen's transformation, IV, 391; volume of tetrahedron, IV, 462; involution of six lines, IV, 582, 593, VII, 66; lines in involution, V, 1—3; quadric cones, V, 6; quartic surfaces, V, 69; canonic root of binary quantic, V, 103—5; discriminant of quintic, V, 592; conic and cubic, V, 608; derivation of points of cubic curve, VI, 20; quintics, VI, 147—8; on roots of algebraical equation, VI, 147; bicorn, VI, 158; foci of conics, VII, 1—4; differential operators, VII, 8; cubic transformation of elliptic functions, VII, 44; Cartesian curves and cubic curve, VII, 556; spherical problem, VII, 563; discussions with, on covariants, VIII, xv; theory of matrices, VIII, xxxii—iii; root-limitation, IX, 22, 39; elimination, IX, 43, XIII, 545—7; residuation, IX, 211; quartic curves and functions of a single parameter, IX, 315—7; scalene transformation, IX, 527, 534; development of idea of Eisenstein, X, 58—9; numerical generating function, X, 339; linkwork, X, 407; N.G.F. of binary septic, X, 408—9; theorem relating to covariants, X, 430; on trees, X, 598—600; theory of tamisage, XI, 409—10; partitions, XII, 217; perpetuants, XII, 251, 252, 253; non-unitary partition tables, XII, 273; d'Alembert-Carnot geometrical paradox, XII, 305—6; umbrae, XII, 347; invariants and reciprocants, XII, 393; a Diophantine relation, XII, 596; *Nature*, notice in, XIII, 43—8; syzygetic relations, XIII, 224; reciprocants, XIII, 333—5, 366, 379—81; lectures on theory of reciprocants, XIII, 381—98.

**Symbolical Forms**: of hyperdeterminants, I, 80—94; of covariants, I, 577, 585.

**Symbols**: modular functions, IV, 484—9.

**Symmetric**: the term, I, 410.

**Symmetrical**: the term, IV, 599, 604, VI, 524—5, XI, 496.

**Symmetric Covariants**: II, 233.

**Symmetric Curve**: and system of equations, I, 473.

**Symmetric Functions**: of roots of an equation, II, 417—39, 602—3; partitions, II, 418; tables, II, 423—39; resultant of a system of two equations, II, 440—53; tables, II, 445—53, VI, 292—9; of the roots of certain systems of two equations, II, 454—64, VI, 292—9; conditions for existence of given systems of equalities among roots of an equation, II, 465—70, 603—4, VI, 300—12; tables, II, 467; conditions for existence of systems of equal roots of binary quartic or quintic, VI, 300—12; and theory of equations, X, 6—8; non-unitary, and seminvariants, XII, 239—48, 275; tables of roots, XII, 263—72, 273—4; a differential operator, XII, 318; seminvariants, XIII, 265—332; (*see also* Seminvariants).

- Symmetroid**: the term, VII, 134, 280; lineo-linear correspondence of quartic surfaces, VII, 157—9; and Jacobian, VII, 160—3, 175; with given nodes, VII, 163—6; and decadianome, VII, 256, 259; and circumscribed cone, VII, 258—9; theory, VII, 264.
- Symmetry**: Sylvester on, XIII, 45.
- Symptose**: the term, I, 523, 529, 557—8.
- Syntypic**: the term, VII, 123.
- Système Linéaire**: of Laguerre is a matrix, II, 604.
- System of Equations**: order of, I, 457—61, 589; connected with Malfatti's problem, I, 465—70; note, I, 532—3, 589; algebraical, XI, 39—40.
- Szyzgant**: the term, XII, 251; and seminvariants, XII, 257—62.
- Szyzgies**: of degree six, VI, 148—53; of binary quintic connected, VII, 334; for binary cubic, IX, 55; of quintic, X, 346—55; of sextic, XII, 257—62; of binary quartic, and elliptic integrals, XIII, 32; Sylvester's work in, XIII, 46; syzygetic relations among powers of linear quantics, XIII, 224—7; and seminvariants, XIII, 310.
- Tables, Brit. Assoc. Report on Mathematical**: IX, 461—99; introductory, IX, 461—2; of divisors and prime numbers, IX, 462—70; prime roots, IX, 471—7; Pellian equation, IX, 477—80; partitions, IX, 480—3; quadratic forms, IX, 484—6; binary, ternary, quadratic, and higher forms, IX, 486—93; complex theories, IX, 493—9.
- Tables**: linear transformations, I, 108; of covariants for quadratic, cubic, quartic, quintic, II, 276—81, II, 310—35; of covariants  $M$  to  $W$  of binary quintic, II, 282—309; covariants for sextic, II, 314—5; for septic, II, 315—6; for octavic, II, 316—8; for nonic, II, 318—9; of concomitants of ternary quadric, II, 322—3; of ternary cubic, II, 323—9, 331—5; of symmetric functions of roots of equation, II, 423—39; of resultants of two equations, II, 449—53; Sturmian functions for equations from second to fifth degrees, II, 471—4; disturbing function in lunar theory, III, 299—308, 311—8, VII, 516, 519—24, 525—7; of functions in theory of elliptic motion, III, 360—474; Degen's, for Pellian equation, IV, 40; equation of differences, IV, 246—56, 280—91; Arbogast's method of derivations, IV, 274—5; concomitants of ternary cubics, IV, 333—41; Tschirnhausen's transformation for quartics, IV, 373—4, 379—80; and for quintics, IV, 387—90; numerical expansions, IV, 470; polyacra, V, 44; binary quadratic forms, V, 141—56, 618; properties of scrolls, V, 171—2; axial systems of polyhedra, V, 532—9; curves in space, V, 616; for prime or composite modulus, VI, 83—6; aszyzygetic covariants, VI, 149—152; quantics, VI, 167—8; resultant of a system of two equations, VI, 292—9; conditions for existence of systems of equal roots of quartic or quintic, VI, 300—12; singularities of cubic surfaces, VI, 363; also lines and planes, VI, 373; Legendre's elliptic functions, VII, 20; geodesic lines on oblate spheroid, VII, 23; rational transformation between two spaces, VII, 210—3, 224; nodal quartic surfaces, VII, 283, 287, 291, 296; quartic surfaces, VII, 310, 609—10; irreducible covariants of binary quintic, VII, 341—6; planogram No. 1, VII, 439—40; ditto No. 2, VII, 450—1; geodesic lines on ellipsoid, VII, 504—6; binary cubic forms, VIII, 51—64; theory of curve and torse, VIII, 81—4; Pineto's of logarithms (review), VIII, 95—6; cones satisfying six conditions, VIII, 100; geodesic lines, particularly on quadric surface, VIII, 196—9; in-and-circumscribed triangle, VIII, 214—21; centro-surface of ellipsoid, VIII, 365; Steiner's surface, IX, 7; transformation of elliptic functions, IX, 128—35, 163; Newcomb's planetary, IX, 181—4; projection of skew hyperboloid of revolution, IX, 240; classification for mathematical, IX, 424—5; report on mathematical, IX, 424—5; chemical trees, IX, 436—43, 446—8, 450—60, 544—5; double theta functions, X, 168—9, 171, 172—3; regular solids, X, 270—3; concomitants of quintic, X, 349—55, 362—9, 370—6, 377—94, 397—400; transvectants for quintic, X, 378—394; Kummer hexads, X, 506; theta functions, X, 507—10, 513—28, 530—6, 540—2, 544—6; theory of numbers, trisection, XI, 89; ditto quartisection, XI, 94; Reuschle's, of prime roots, XI, 95—6; of finite differences, XI, 144—7; connected with polyhedral function, XI, 158—9, 192; covariantive, XI, 272—80; Schubert's

**TACINVARIANT—TETRAHEDROID.**

136

numerative geometry, XI, 286; theorems of squares, XI, 299—313; theory of numbers, XI, 316; concomitants of ternary cubic, XI, 345—7; literal, for binary quantics, otherwise a partition table, XI, 357—64; for binary sextic, XI, 372—6, 377—88; covariantive, XI, 409—10; Plücker's equations, XI, 472; of Gauss, XI, 545; symmetric functions of roots of an equation, XII, 263—72, XIII, 272—4, 288; non-unitary partition, XII, 273—4; seminvariant, XII, 275—89; orthomorphosis of circle into parabola, XII, 336; of groups, orders two to twelve, XII, 643—56; Wallis's investigation for  $\pi$ , XIII, 23—5; quadri-invariant and cubinvariant of quadri-quadric function, XIII, 68; partitions of a polygon, XIII, 95, 112; theory of rational transformation, XIII, 116; substitution groups for two to eight letters, XIII, 118—49; corrected seminvariant for weights 11 and 12, XIII, 217—23; of conjugates, XIII, 303; seminvariants and symmetric functions, XIII, 311, 313, 331—2; of pure reciprocants to weight 8, XIII, 333—5; report of British Association committee on Pellian equation, and tables, XIII, 430—67; omega and theta functions, XIII, 558—9.

**Tacinvariant**: the term, IV, 607.

**Tac-locus**: in singular solutions, VIII, 533.

**Tacnode**: defined, II, 28—32, V, 266.

**Tactic**: and algebra, V, 293—4; the term, XI, 443; (*see also* Arrangements, Groups).

**Tactinvariant**: of two quantics, II, 320; the term, V, 305.

**Tactions**: analytical solution, III, 255—7; formulæ, IV, 510—2; Casey's equation, VI, 543; and trizomal curves, VI, 575; problem of, XIII, 150—69.

**Tait, P. G.**: arrangements, X, 245; quaternions, XII, 303, 475, XIII, 541—4; finite differences, XII, 412.

**Talbot, W. H. F.**: curve of, IV, 123.

**Tamisage**: Sylvester's theory of, XI, 409—10.

**Tangential**: defined, II, 558; of a curve, IV, 188.

**Tangent Lines**: and surface, XI, 630, 632—4.

**Tangent Omals**: VI, 467—9.

**Tangent Planes**: and surface, XI, 630, 632—4.

**Tangents**: and two-dimensional geometry, II, 575; inflexional and chief, VIII, 157, 294; singular of a quartic, X, 603; in *Ency. Brit.*, XI, 564—5, 579—80; (*see also* Bitangents).

**Tannery, J.**: linear differential equations, XII, 394.

**Tantipartite**: the term, I, 584, II, 517, IV, 464, 604.

**Taylor, C.**: locus *in plano* problem, VII, 599; general theory of surfaces, XII, 42—4.

**Taylor, H. M.**: inversion, IX, 18; partitions of a polygon, XIII, 93, 112.

**Taylor's Theorem**: Lagrange's demonstration, VIII, 493—5, 519; note on, VIII, 524.

**Tchebycheff, P.**: theory of numbers, XI, 616.

**Terminology**: recent mathematical, IV, 594—608.

**Terms**: in symmetrical determinant, IX, 185—90.

**Ternary**: the term, IV, 604, VI, 464.

**Ternary Cubics**: relation between two, IV, 79—81; memoir on quantics, IV, 325—41; form problem, VII, 548; the 34 concomitants, XI, 342—56; canonical form, XI, 343.

**Ternary Quadratics**: resultant of three, IV, 349—58.

**Ternary Quadrics**: and involution, XIII, 350—3.

**Ternary Quantics**: and bitangents of plane curve, IV, 188; involution, V, 301—9.

**Tetrad**: the term, XII, 590; systems of, XIII, 425—9.

**Tetrahedra**: reciprocals, III, 7; axial systems, V, 531—9; note on, V, 557—9; and cubic surfaces, VII, 607; correspondence of points in relation to two, VIII, 200—8; Steiner's surface, IX, 1—12; in perspective, IX, 209—10; automorphic function for, XI, 169, 179—83, 184, 212—6.

**Tetrahedral Surfaces**: VII, 48—53, 54—65.

**Tetrahedroid**: and wave surface, I, 302—5, 587; 16-nodal quartic surfaces, V, 431—7; the term, VI, 21, X, 252; and scrolls, VII, 245; as particular case of 16-nodal quartic surface, X, 437—40.

**Tetrazomal** (*see* Polyzomal Curves).

**Text-Books**: on determinants, elimination and higher algebra, iv, 608.

**Theory of Equations** (*see* Equations, Theory of).

**Theory of Groups** (*see* Groups).

**Theory of Numbers** (*see* Numbers, Theory of).

**Theta Functions, Memoir on Single and Double**: x, 463—565; historical, x, 463—4; Part I, x, 464—76; definitions, x, 464—5; allied functions, x, 465—6; even-integer alteration of characters, x, 466; odd ditto, x, 466; even and odd functions, x, 467; quarter-periods unity, x, 467—8; conjoint quarter quasi-periods, x, 468—9; product-theorem, x, 469—71; résumé of ulterior theory of the single functions, x, 471—3; ditto, double functions, x, 474—5; remark as to notation, x, 475—6; Part II, x, 476—97; notation, x, 476; constants of the theory, x, 477—8; product theorem, x, 478—80; the square-set, x, 481—2; relation between the constants, x, 482—3; product-sets, x, 483—4; comparison with Jacobi's formulæ, x, 485; the square set, x, 485—7, 488—9; elliptic integrals of third kind, x, 489—90; addition formulæ, x, 491—2; doubly infinite product forms, x, 492—4; transformation  $q$  to  $r$ , x, 494—7; Part III, the double theta functions, x, 497—565; product-theorem, x, 497—506; tables, x, 506—8; product-theorem and its results, x, 509—39; tables, x, 513—39; the first set, x, 539; second ditto, x, 540; third ditto, x, 541; fourth ditto, x, 542; considerations, x, 543—8; résumé, x, 548; 16-nodal quartic surfaces, x, 548—51;  $x, y$  expressions of theta functions, x, 551—5; further results of product-theorem, x, 555—7; differential relations connecting theta and quotient functions, x, 557—9; differential relations of theta functions, x, 559—61; ditto,  $u, v, x, y$ , x, 561—5.

**Theta Functions**: of Jacobi, i, 136, 290; and elliptic integrals, xi, 41—6; theory of multiple, xi, 242—9; notation, xi, 243—5; evolution, xi, 451—5; the term, xi, 532; linear transformation, xii, 337—43; formula relating to zero value of, xii, 442—3; Smith's memoir, xiii, 558—9; (*see also* Abelian, Double Theta, Elliptic, Single Theta, and Triple Theta, Functions).

**Third Class**: curves of, ii, 395—6.

**Thomae, J.**: linear differential equations, xii, 394, 396, 444; theta functions, xii, 442.

**Thomson, F. D.**: tangents of conic, v, 578.

**Thomson, J.**: mechanical integrator, xi, 53.

**Thomson, W.** (*see* Kelvin, Lord).

**Three-bar Motion**: ix, 551—80, xi, 481, xiii, 505—16.

**Three Bodies**: problem of, iii, 97—103, 183, iv, 548—552; in a line, iv, 538—40; other cases, iv, 540—1.

**Time and Number**: xi, 442—4.

**Tissot, A.**: spherical pendulum, iv, 534, 593.

**Titus, Colonel**: arithmetical problem, iv, 171—2.

**Todhunter, I.**: conics, iv, 481; Taylor's theorem, viii, 493—5;  $q$ -squares, x, 27; probabilities, x, 600.

**Topography**: contour and slope lines, iv, 108—11, 609.

**Topology**: of space, vi, 22; of chessboard, x, 609.

**Torsal**: the term, vi, 334, 336, 341, 355, 582—5.

**Torse, on a Certain Sextic**: vii, 99—114; introductory, vii, 99—100; theorem of four binary quartics, vii, 100; standard equation of unicursal quartic, vii, 101; tangent line and osculating plane of unicursal quartic, vii, 101; its final form, vii, 102; determination of sextic torse, vii, 102—3; principal sections of ditto, vii, 103—5; partial determination of equation, vii, 105; determination of the unknown coefficients, vii, 106—11; equation of sextic torse, vii, 112; ditto, and centro-surface of ellipsoid, vii, 113—4.

**Torses**: the term, v, 182, xi, 573; and scrolls, v, 199—200; and curves, v, 505—10; a special sextic developable, v, 511—9; singularities, vi, 601; on some sextic, vii, 116—7, 118—20; circumscribed to two quadrics, viii, 520—1; on a sextic, x, 68—72; depending on elliptic functions, x, 73—8;

**TORSION—TRANSFORMATION.**

138

and certain octic surfaces, x, 79—92; kinds of, xi, 227; in *Ency. Brit.*, xi, 628, 629—32; and surfaces, xi, 632; and non-Euclidian plane geometry, xii, 222; (*see also* Developables).

**Torsion**: the term, i, 234, xiii, 232, 234.

**Tortolini, B.**: envelopes, parallel curves and surfaces, iv, 123—33; parallel surfaces of ellipsoid, iv, 133.

**Tortuous Curves** (*see* Curves).

**Torus**: the term, vii, 246, viii, 25; paper by Darboux, vii, 247; the conic-, ix, 519—21.

**Townsend, R.**: inertia, iv, 566, 593; confocal quadrics, viii, 520.

**Tractor**: the term, vii, 73—5, x, 269; six coordinates of a line, vii, 85—6, 93—5.

**Trajectories**: root-limitation, ix, 22—7; and orthomorphosis, xiii, 170.

**Transcendental Analysis** (*see* Function).

**Transcendental Function**: the term, xi, 524.

**Transcendental Integrals** (*see* Abelian Integrals).

**Transcendent, Gudermannian**: v, 86—8, 617.

**Transformation**: of quadratic forms, ii, 145—9, 192—201, 215; of two quadric functions, iii, 129—31; the term modulus of, iv, 605; plane curves, vi, 1—8, 593, viii, 387; Cremona's, vi, 22—3; polyzomal curves, vi, 553, 565—6; two quantics into each other, viii, 385—7; unicursal surfaces, viii, 388—93; binary quadratic form, viii, 398—400; doubly infinite products, x, 494—7; theories, xi, 482; Landen's, xi, 584; double theta functions, xii, 358—89; of order 11, and modular equation, xiii, 38—40; modular equation for cubic, xiii, 64—5; (*see also* Special Headings below).

**Transformation, Automorphic**: iv, 416, v, 439; of binary cubic function, xi, 411—6.

**Transformation, Cubic**: in elliptic functions, ix, 522—6.

**Transformation, Geometric**: vii, 121—2.

**Transformation, Homographic**: xi, 189—90, 196—208.

**Transformation, Linear**: ii, 225, xi, 237—41; imaginary linear, vi, 183—6; lineo-linear, vii, 215—6, 236—8; of theta functions, xii, 337—43.

**Transformation of Coordinates**: i, 123—6, 586, iv, 552—9, vii, 95, 415—7, xi, 136—42, 558—61; formulæ, vii, 97—8.

**Transformation of Elliptic Functions**: i, 120—2, 585, v, 472, ix, 103—6, 244—5, x, 333—8, 611, xi, 26, xii, 416—7, 535—54, xiii, 29—32, 490—2, 505—34, 535—55, 556—7.

**Transformation of Elliptic Integrals**: i, 508—10, iv, 60—9, 609.

**Transformation of Equations**: ix, 42, 48—51; of differential, v, 78—9.

**Transformation of Integrals**: i, 383, iii, 1—4, 438—44, ix, 250—2.

**Transformation of Tschirnhausen**: vi, 165—9, xi, 396; for cubics, iv, 364—7, xiii, 421; quartics, iv, 368—74; quartics and quintics, iv, 375—94, v, 449—53; theory of equations, xi, 509.

**Transformation, Orthomorphic**: of a circle into itself, xiii, 20.

**Transformation, Quadric**: of elliptic functions, xii, 58; between two planes, xii, 100—1.

**Transformation, Rational, between Two Spaces, Memoir**: vii, 189—240; introductory, vii, 189—90; general principle, vii, 190—3; homographic transformation between two lines, vii, 193—7; rational ditto between two planes, vii, 197—213, 216—21; tables, vii, 210—3; quadric transformation between two planes, vii, 213—6; quadric transformation any number of times repeated, vii, 219—21; reduction of general rational transformation to a series of quadric transformations, vii, 222—4; rational transformation between two spaces, vii, 224—9, 238—40; ditto quadri-quadric, vii, 229—30; ditto quadri-cubic, vii, 230—3; ditto cubo-cubic, vii, 233—8; this principal system consists of six lines, vii, 234—6; principal system of a proper sextic curve—the lineo-linear transformation between two spaces, vii, 236—8.

**Transformation, Rational**: of plane curves, vi, 1—8; does not alter deficiency, vi, 3; between two planes and special systems of points, vii, 253—5; note on a theory of, xiii, 115—6.

**Transformation, Rectangular**: xi, 421—8.

**Transformation, Scalene**: of plane curve, ix, 527—34.



- Transformation, Septic**: of elliptic functions, x, 333—8, xii, 535—54.
- Transformation, Special Quartic**: of elliptic functions, ix, 103—6.
- Transmutant**: defined, ii, 515.
- Transpose**: the term, ii, 493.
- Transvectant**: form of covariants, viii, 404—8; (*see also* Derivatives).
- Trees**: analytical forms called, iii, 242—6, iv, 112—5, xi, 365—7; curves which satisfy given conditions, vi, 260; application to chemistry, ix, 202—4, 427—60, 544—5; problem and solution, x, 598—600; a theorem on, xiii, 26—8.
- Triads**: of seven and fifteen things, i, 481—4, 589; of fifteen things, v, 95—7.
- Triangle**: harmonic relation of point and line, ii, 96—7; reciprocal triangles, iii, 5—7; circumscribed about conic, properties of, iii, 29—34; theorem of line and conic, v, 100—2; problems, v, 564, 566, 593, vii, 581, 599, x, 575; locus in relation to, vi, 53—64; locus and envelope, vi, 72—82; solution of problem in *Principia*, Bk I. Sec. V. Lemma xxvii, vii, 30; potential of, ix, 270—1; non-Euclidian, xiii, 482—3; nine-point circle of a plane, xiii, 520—1.
- Triangle, In-and-circumscribed, the Problem of, Memoir**: viii, 212—57; introductory, viii, 212—3; tables, viii, 214—21; principle of correspondence, viii, 222—5; locus of a free angle, viii, 225—7; application of theory to locus, viii, 227—8; solutions for 52 cases, viii, 228—51; the case 52, viii, 251—57.
- Triangle, In-and-circumscribed**: ii, 87—90, 91—2, 138—44, 145—9, iii, 67—75, 229—41, iv, 435—41, v, 489—92, 549—50, 553, viii, 565—6; a posteriori demonstration of porism, iii, 80—5; (*see also* Porism).
- Triangle, Spherical**: theorem of, iv, 80, xi, 97—9; nine-point circle of, xiii, 548—51.
- Tricircular Sextic**: ix, 562—70.
- Trident Curve**: classification, v, 355—69, 395.
- Trigonometry**: transformation of an expression, ii, 45—6; multiple sines, x, 1—2; theorem in partitions and, x, 16; identities, xi, 38, xiii, 538—40; formulæ, xii, 108; an expansion, xii, 319—20.
- Trigonometry, Spherical**: theorem, iv, 80, xi, 97—9; identity, viii, 525; foundation, xi, 570.
- Trigonometry, Spheroidal**: ix, 197.
- Trihedral Pair**: the term, vi, 374.
- Trinodal Quartic**: x, 602; (*see also* Quartic Curves).
- Tripair**: the term, x, 450—1.
- Tripartite**: the term, vi, 464.
- Triple Tangent Planes**: of cubic surfaces, i, 445—56, 589, vi, 372, 376.
- Triple Theta Functions**: x, 432—6, xi, 47—9; algorithm for characteristics of, x, 441—5; and quartic curves, x, 446—54.
- Tris**: the abbreviation in groups, xiii, 119.
- Trisection**: in theory of numbers, xi, 84—96.
- Tritom**: and point, v, 138.
- Trivector**: the term, vii, 400, 401; planet's orbit from, vii, 406—12, 426—8.
- Trizomal** (*see* Polyzomal Curves).
- Trope**: the term, vi, 330, viii, 73, x, 54—5.
- Tropical Point**: the term, xii, 433.
- Truel, H. D.**: imaginaries, xii, 467.
- Tschirnhausen's Transformation**: vi, 165—9, xi, 396; for cubics, iv, 364—7, xiii, 421; quartics, iv, 368—74, 375—82, v, 449—53; quintics, iv, 382—94; theory of equations, xi, 509.
- Tucker, R.**: geometrical interpretation, x, 581.
- Twisted**: the term, vi, 524—5.
- Two Centres Problem**: iv, 524—32.
- Two-way Point**: the term, xiii, 507.

## UEBERSCHIEBUNG—WARREN.

140

- Ueberschiebung**: the word, I, 585; (*see also* Derivations).
- Ultra-elliptic Functions** (*see* Hyperelliptic Functions).
- Umbilicar Centres**: the term, VIII, 326, 351.
- Umbilici**: and differential equations, v, 115—30; curves of curvature near, VII, 330—1; on surface of  $n$ th order, VIII, 320; the term, XI, 581; (*see also* Geodesic Lines).
- Umbral**: theory of seminvariants, XIII, 266; notation of, and seminvariants, XIII, 301—6.
- Umbræ**: the term, XII, 347.
- Unibasic**: the term, XII, 642.
- Unicursal Curves**: VI, 2.
- Unicursal Octics**: XII, 310.
- Unicursal Quartics**: standard equation, VII, 101; tangent line and osculating plane, VII, 101; its final form, VII, 102.
- Unicursal Surfaces**: transformation of, VIII, 388—93.
- Unicursal Twisted Quartic**: XII, 428—31.
- Uniform Convergence**: XIII, 342—5.
- Uniform Function**: XII, 433.
- Uniform Series**: defined, IV, 457.
- Unipartite**: the term, VI, 464.
- Uniplanar-node**: the term, VI, 361.
- United Points**: in correspondence, VI, 9.
- Unity**: prime roots, XI, 56—60; imaginary roots, IX, 263; ninth roots, XIII, 66.
- Universal Algebra**: Sylvester's theory of, XIII, 47.
- Unode**: the term, VI, 362.
- Uranus**: Newcomb's work, IX, 180—4.
- Vacuity**: Sylvester's theory of, XIII, 47.
- Valentin, H.**: curves in space, v, 613—7; theory of surfaces, XI, 14—6.
- Values**: principal, of complex expression, I, 309; of  $\Pi i = \Gamma(1+i)$ , XIII, 522—4.
- Vandermonde, A. T.**: solution by radicals, x, 11; theory of equations, XI, 513.
- Variables**: (2, 2) correspondence of two, IX, 94—5; normal in dynamics, IX, 111; imaginary, XI, 439—41.
- Variation**: of parameters in rotation of solid body, I, 242; of arbitrary constants, III, 161—200; of planet's orbit, III, 516—8, VII, 541—5.
- Variations, Calculus of**: Jacobi on, III, 174; problem in, VII, 263.
- Velocities, Virtual**: general equation, IX, 205—8.
- Veronese, G.**: Pascal's theorem, VI, 594; four-dimensional space, XI, 442.
- Vertices of Cones** (*see* Cones).
- Vicinal Surfaces**: conormal correspondence of, VIII, 301—8; (*see also* Surfaces).
- Vieta, F.**: tactions, XIII, 152.
- Virginia**: Key and Sylvester, professors at, XIII, 43.
- Virtual Velocities**: general equation, IX, 205—8.
- Walker, S. C.**: the anharmonic-ratio sextic, VII, 314—5; orbit of Neptune, IX, 180.
- Wallis, John**: biographical notice, XI, 640—3; multiple algebra, XII, 466; his expression for  $\pi$ , XIII, 22—5.
- Walton, W.**: root-limitation, IX, 39; maxima and minima, IX, 40—1; transformation of equations, IX, 42; integration and definite integrals, IX, 56—63; ray planes and biaxial crystals, IX, 107—9.
- Waring, E.**: equation of differences, IV, 240, 252; sum of  $m$ th powers of the roots of an equation, XIII, 213—6.
- Warren, J.**: on binary cubics v, 289; curvilinear coordinates, XII, 1—18; multiple algebra, XII, 460, 468.

- Wave Surfaces**: tetrahedroid, I, 302—5, 587, VI, 21; on, IV, 420—6, 432—4, XIII, 238—52; equation of, in elliptic coordinates, XI, 71—2; evolution of Fresnel's, XI, 449.
- Weber, H. H.**: triple theta functions, X, 444, 446—54; bitangents of quartic, XI, 221—3; elliptic functions, XIII, 559.
- Weddle, M.**: cubic curves, IV, 497; quadric cones, V, 4.
- Weierstrass, K.**: doubly infinite product, I, 586; function  $Al(x)$ , I, 587;  $al$ -functions, V, 33—7; Steiner's quartic surface, V, 423; infinite products, VIII, XI; triple theta functions, X, 432, 434; theta functions, X, 499; elliptic integrals, XI, 64; theta functions, XI, 242; theory of functions, XI, 451—2, 454; function of, XI, 540; Abelian functions, XII, 98; and Jacobian elliptic functions, XII, 425—7; transformation in elliptic functions, XIII, 29, 31.
- Weight**: and partitions of a polygon, XIII, 110.
- Weingarten, J.**: application of surfaces to each other, XIII, 253—64.
- Whewell, W.**: dynamics, IV, 518; mathematics, XI, 431—2; number and time, XI, 442.
- Whitworth, W. A.**: triangles and conics, V, 593.
- Wiener, C.**: model of cubic surface with twenty-seven real lines, VIII, 366—84.
- Wilbraham, H.**: probabilities, II, 594—8, V, 85.
- Wilkinson, M. M. U.**: Taylor's theorem, VIII, 519; chances, X, 588; rectangular transformation, XI, 421—8.
- Wilkinson, T. T.**: circle and points, V, 560.
- Wilson, J.**: theorem of, XI, 598; and proof, XII, 45.
- Wolstenholme, J.**: relation among derivatives of a function, X, 590—2; conic and cubic, X, 605—7.
- Women**: Cayley and higher education of, VIII, XIX.
- Woolhouse, W. S. B.**: theorem of integration, problem, VII, 588; algebraical theorem, X, 594—6.
- Worms, H.**: rotation of the Earth, IV, 537, 593.
- Woven**: the term, XIII, 121.
- Wright, E.**: Mercator's projection, XI, 448.
- Wright, T. C.**: on Cayley as a law-student, VIII, XIV.
- Writing of Cayley**: frontispiece, VIII.
- Wronski, H.**: theorem of, IX, 96—102.
- Young, G. P.**: soluble quintic equations, XIII, 88; theory of groups, XIII, 336, 533.
- Young, J. R.**: sums of squares, II, 52; theorems of squares, XI, 294, 301.
- Zech, P.**: wave surface, IV, 420—5, 432—4.
- Zero-values**: of theta functions, X, 499—500, XII, 442—3; (*see also* Theta Functions).
- Zeuthen, H. G.**: curves and developables, I, 587; sextactic points, V, 545; curves which satisfy given conditions, VI, 191, 192, 200—26, 594; capitals, VI, 280; reciprocal surfaces, VI, 577—81, 591, 596—601, XI, 234; cubic surfaces, VI, 595—6; correspondence of two points on a curve, VII, 39; theory of conics, VII, 552—4; theory of curve and torse, VIII, 72; table of singularities of torse, VIII, 81—2; degenerate forms of curves, XI, 220; quartic curves, XI, 480; systems of curves, XI, 486—7.
- Zolotareff, G.**: elliptic integrals, X, 143.
- Zomal**: defined, VI, 473; (*see also* Polyzomal Curves).
- Zornow, A. R.**: mathematical tables, IX, 486.