

A

- abscissa**, 5, 21, 57
- absolute maximum**, 170, 172, 176
- absolute minimum**, 170, 172, 201
- absolute value**
 functions, 7, 10–11, 47–48, 50, 56, 60, 135, 137, 140, 142–144, 151–152, 156, 164, 166, 168, 170, 198, 283, 298, 304, 394, 445, 641
 graphs, 72, 86, 118, 221, 386, 461
 inequalities, 53, 147–148, 150–151, 158, 198, 201, 221
 of complex numbers, 587, 589
- acceleration**, 76–77, 157, 220, 223, 242, 255, 289, 291, 297, 311
- accounting**, 24, 45, 47, 50, 766, 768, 896
- acoustics**, 559, 571
- acute angle**, 280, 284, 308, 310, 336, 469, 492
- addition**, 421
 of complex numbers in rectangular form, 609
 of functions, 14, 17, 18, 25, 58
 of matrices, 79, 120, 212
 of terms, 64
 of vectors, 496
- additive**
 identity matrix, 80
 inverse, 80
- advertising**, 83, 799, 931
- aeronautics/aerospace**, 211, 485, 487, 499, 504, 657, 695, 701
- agriculture**, 20, 21, 105, 117, 264, 629, 676, 702, 896
- algebraic vectors**, 493–499
- alternate interior angles**, 300, 314, 612–613
- alternate optimal solutions**, 114–117
- altitudes of triangles**, 36, 302, 731
- ambiguous case**, 320
- Amer, Tahani R.**, 969
- amplitudes**, 368, 370–374, 378, 381–382, 389, 391, 393–394, 402, 412–413, 415, 498, 504, 560, 587, 594–595, 607, 641, 845
- amusement parks**, 255, 630
- anagram**, 797, 850
- analytic geometry**, 157, 167, 188, 468, 615, 618, 652
- angles**
 bisector of, 419, 473
 coterminal, 279–281, 298, 304, 318, 336, 555
 measures of, 419, 461
 of convex polygons, 331, 394, 762
 of depression, 300, 302–303, 306, 309, 311, 314, 317, 326
 of elevation, 300–302, 306, 309–310, 314, 317, 332, 445, 455, 821, 874
 of incidence, 284, 289, 311, 821
 of incline, 289, 290, 297
 of refraction, 284, 289, 311, 461, 821
 of rotation, 670, 673–674, 676
 sum of triangles, 319
 vertex, 307
- angular displacement**, 352–353, 355, 357, 377, 414
- angular velocity**, 352–357, 376–377, 386, 413–414, 461
- animation**, 88, 90, 91, 95, 535–536
- antiderivatives**, 951–960, 970–971, 972
- antilogarithms**, 726, 729, 734, 748, 751
- antilogarithms of natural logarithms (antiln x)**, 734
- apex of the prism**, 444
- apothem**, 300, 302–303, 661
- approximating**
 cube roots, 602
 e , 716
 fifth roots, 602
 fourth roots, 602
 intersections of graphs, 679
 relative maximum and minimum, 173
 zeros of functions, 232, 236–237, 240, 264, 271, 311, 525, 652
- arc length**, 349, 444, 612
- arccosine**, 305–306, 335, 406–412, 416, 703
- archaeology**, 23, 732, 753
- architecture**, 234, 290, 304, 312, 317, 325, 448, 452, 454, 510, 540, 717, 895
- arcsine**, 305–306, 335, 406–412, 416
- arctangent**, 305, 406–412, 416
- area**, 317, 548, 963
 of circles, 77, 549, 579, 969
 of circular cross sections, 975
 of circular sectors, 347, 358, 377, 417, 444, 874
 of ellipses, 640, 947
 of octagons, 316
 of parallelograms, 316, 331, 549
 of pentagons, 316, 322, 357, 732
 of polygons, 303, 548
 of rectangles, 179, 341, 621, 961–962
 of regions bounded by curves, 926
 of regular polygons, 303, 429
 of rhombi, 326, 331
 of shaded regions, 257, 533, 549, 684, 966, 972–973, 983
 of squares, 77, 272, 341, 476, 828, 858
 of triangles, 104, 144, 302, 314–316, 329–330, 338, 350, 461, 548–549, 613, 630, 669, 858, 907
 under a curve, 961–968, 977, 980
- Argand plane**, 586, 607
- argument of complex numbers**, 587
- Aristotle**, 319
- arithmetic means**, 31, 754–755, 757–759, 761–762, 791, 897, 901, 911, 914–915, 939
- arithmetic sequences**, 757–762, 765, 781, 791, 828, 830
- arithmetic series**, 759, 791, 829–830, 858
- arrangements**, *see* *permutations*
- art**, 711, 841
- Aryabhata**, 462
- Associative Property**, 86
- astronomy**, 256, 282, 525, 637–638, 640, 661, 666–667, 676, 691, 731
- asymptotes**
 horizontal, 180–184, 186–187, 200, 436, 492, 705–706, 728
 of conjugate hyperbolas, 652
 of hyperbolas, 642–652
 slant, 183–184, 186–187, 197, 200, 560, 765
 vertical, 180–187, 200, 492, 705, 728
- audio technology**, 358, 561, 563, 566
- augmented matrices**, 97, 106
- automobiles/travel**, 189–190, 211, 256, 310, 354, 505, 508, 660, 850, 867, 907, 929
- averages**, 482, 617, 753–755, 887, 983
 class marks, 890–891, 893, 895, 901, 913, 934
 mean, 50, 111, 150, 661, 715, 897–900, 903–907, 914, 916–917, 920–921, 923, 925, 934, 937, 939, 943
 measures of central tendency, 897–908, 933
 median, 44, 619, 897–900, 903–907, 910, 914–917, 925, 933–934, 937, 939
 mode, 897, 899–900, 903–906, 917, 925, 934, 937
- aviation**, 11, 61, 249, 282, 303, 311, 317, 332, 476, 520, 532, 560, 573, 578, 650, 652, 709, 731, 798, 821, 880
- axis of symmetry**, 137, 691
 for ellipses, 631
 for hyperbolas, 137, 653–661, 691
 for parabolas, 653–661


B

Babylonians, 97, 367, 534
back-to-back bar graph, 889
backsolving, 202
banking, 715, 746, 773, 816, 820, 845, 975
ballooning, 317
bar graphs, 889, 924, 934, 937
 back-to-back bar graph, 889
 histogram, 890, 892, 933–934, 938
base, 71, 192
 angles, 302, 492, 516
 of exponential expression, 704
 of isosceles triangles, 310
 of a logarithm, 718–719, 726, 728, 733
basic counting principle, 837, 855, 882
Bernoulli, Jakob, 462
Bernoulli, Johann, 367
best-fit lines, 38, 40–41, 51, 60, 258–259, 270, 573
bimodal, 899
binomial
 expansion, 802, 804, 821, 832, 875–876, 948
 experiments, 876, 878, 924
 factors, 225, 235, 461, 732
 representation, 805
 Theorem, 803–805, 807, 814, 828, 832, 851, 875–880, 884
biology, 167, 290, 385, 392, 574, 577–578, 709, 717, 723, 745, 748, 772, 819, 850, 947
biomedical engineering, 136
bisectors
 of acute angles, 470, 472
 of obtuse angles, 473, 480
 of segments, 419
block diagrams, 542
blueprint, 56, 510
boating, 302, 303, 368, 371, 375, 391, 518, 677
Boolean operators and statements, 169
Borts, Autumn, 319
botany, 29, 845, 931, 948
boundary, 52–53, 147, 685–686, 722, 728
bounded region, 108, 110
box-and-whisker plots, 908–910, 914–915, 933
Boyle's Law, 651, 737
Brahmagupta, 462
break-even point, 67, 72
broadcasting, 437, 440
Brothers' expression, 716
budgets, 9, 118, 833

business, 13, 14, 19, 25, 28, 31, 37, 44, 48, 49, 51, 55, 56, 72, 110, 111, 114, 115, 116, 144, 171, 175, 178, 228, 235, 247, 290, 318, 343, 347, 510, 630, 660, 708, 805, 822, 825, 864, 873, 924, 958–959, 961, 965, 967, 981


C

calculus, 172, 444, 534
camping, 339
Canter, Georg, 367
capacity, 248
cardioid classical curves, 564–566, 571, 607–608
Career Choices, 12, 105, 136, 221, 312, 358, 420, 499, 598, 622, 703, 800, 851, 896, 976
carpentry, 691, 814
Cartesian coordinate system, 556, 573
cartographer, 430
catenary curve, 715
cause and effect relationship, 41
Cavalieri, Bonaventura, 969
Cayley, Arthur, 97
cellular growth, 792
Celsius temperature, 17, 152
census, 956
center, 623, 626, 763, 880
 of circles, 628, 688
 of ellipses, 631–641
 of hyperbolas, 642–652, 781
central angles, 345–348, 357, 376–377, 413–414, 417, 444, 445, 612, 622, 874
change
 from degree measure to radian measure, 344, 348, 394, 414
 from radian measure to degree measure, 414, 436, 671
 from standard form to normal form, 465
 in signs of polynomial function, 237–238, 424
 of base formula, 728, 730–731, 734, 771
chemistry, 24, 103, 150, 180, 187, 504, 611, 651, 701, 718, 720, 726–727, 729, 737, 799, 960
chess, 799
childcare, 145
circle graphs, 857, 938
circles, 105, 376, 419, 532, 608, 622–630, 658, 663, 684, 687
 central angle of, 345–348, 357, 376–377, 413–414, 417, 444, 445, 612, 874
 circumference of, 410, 560
 circumscribed around polygons, 302, 549, 629
 concentric, 345, 352, 622, 623
 diameter of, 95, 283, 300, 303, 313, 349, 412, 623–630, 660
 inscribed in polygons, 298
 radii of, 105, 192, 210, 226, 289, 293, 298, 300, 302, 311, 316–317, 325, 335, 349, 357, 377, 413, 417, 476, 532, 548, 622–630, 684, 805
 sector of, 346, 349, 444
 segment of, 350
 standard form of the equation of, 624–625, 627
 tangent to lines, 628
 unit, 291–292, 294, 296, 304–305, 335, 343, 345, 422–423, 428, 454, 458, 461, 579, 819, 948
circuits, 249
circular arcs, 345
circular functions, 292, 335
circular permutations, 847–851, 867
circumference, 296, 410, 534, 548, 560, 711, 755
circumscribed circle, 302, 549, 629
cis, 588
civil engineering, 311, 350, 715, 865, 874
classical curves, 564
 cardioid, 564–566, 571, 607–608
 lemniscate, 564–566
 limaçon, 562, 565–566, 607–608, 611
 Spiral of Archimedes, 564–565, 572, 607–608
class interval, 890–895, 917
class limits, 890, 893–894, 901, 917
class marks, 890–891, 893, 895, 901, 913, 934
clocks, 793
clockwise rotations, 92, 671
club activities, 827
coefficient, 40, 68, 73, 106, 205–206, 213, 231, 236, 260, 265–266, 365
 of friction, 256, 429
 matrix, 101, 103
 symmetric, 801
cofunctions, 287, 439, 446
coinciding, 32–33, 35–36, 68, 179
coin flips, 124, 804
collinear points, 31, 273, 845, 939
columns of a matrix, 78–79, 81, 85, 119
column matrix, 78
combinations, 837–845, 881–882, 885–886
common denominators, 432
common difference, 757–761, 833
common factor, 184
common logarithms, 726–728, 737, 749, 751
common ratios of geometric sequences, 764–770, 783, 795, 829–830, 960

- communication**, 135, 264, 324–325, 566, 675, 702, 716, 845, 849
- Commutative Property**, 86
- Commutative Property of Addition for Vectors**, 491
- compare and contrast**, 22, 76, 355, 373, 383, 390, 401, 410, 434, 459, 649, 667, 705–706, 708, 722, 769, 842, 874, 892, 914, 930
- comparison test**, 787, 789, 797
- compass**, 534
- complementary angles**, 446, 612
- complements**, 284, 853
- Complex Conjugates Theorem**, 216
- complex numbers**, 205–207, 216, 267, 580–581, 583, 586, 589–593, 596–597, 601–602, 606–607, 610–611, 697, 810–811, 816
conjugates, 216, 582–584, 591
coordinates, 588
fractions, 125, 483, 567
iteration of, 580–582
moduli, 587
 p distinct roots of, 601–602
polar form of, 588
powers of, 599
products of, 606
quotients of, 593–593, 610
roots of an equation, 207, 210–211, 221, 230, 235, 250, 267–268
- complex plane**, 586–588, 592, 599–600, 606, 817–819
- components of vectors**, 402, 488, 543
- composite functions**, 13, 72, 86, 96, 136, 145, 188, 212, 283, 412
- composition**
of functions, 14–15, 17–18, 25, 31, 37, 44, 58, 61, 104, 151, 158, 445, 720
of reflections, 91
- compound functions**, 382
- compound inequalities**, 54, 136, 318
- compound interest**, 707, 714, 813, 975
- computer**, 88, 90, 91, 168, 504, 535–536, 599, 603, 606, 865
- concentric circles**, 345, 352, 549, 622, 623
- conditional probability**, 868–874
- conic sections**, 623–691
general equations, 662, 667
standard form equations, 633–634, 643, 647, 660
also see circle, ellipse, hyperbola, parabola
- conjugate axes of hyperbolas**, 642–652
- conjugates**, 216, 219, 583, 594
- consecutive integers**, 41, 124, 240, 250, 269, 684
- consistent systems of equations**, 67–68, 70–72, 86, 136, 196
- constant function**, 22, 137, 164, 953
- constant multiple of power rule for derivatives**, 953, 955–956, 971
- constant of variation**, 188, 190, 193–196, 200
- constant rate**, 188
- constant terms**, 365
- construction**, 211, 212, 229, 232, 235, 489, 585, 640, 660, 683, 764, 805, 970, 972
- consumerism**, 49, 67, 69, 142, 157, 168, 188, 201, 253, 304, 772
- consumption function**, 44, 50
- continuity of an interval**, 161
- continuity test**, 160, 162, 165–166, 179, 199, 874
- continuous compound interest**, 713
- continuous functions**, 159–162, 165–166, 168, 179, 197, 199, 283, 430, 706, 782–783, 821, 942, 970
- convergent series**, 786–793, 797, 805, 821, 829, 831, 907
comparison tests, 787, 789, 797
ratio test for, 787
- convex limacon**, 566
- convex polygonal set**, 108, 179, 283
- coordinate axes**, 382, 687
- coordinate geometry**, 272, 615–622
- coordinate systems**, 20, 93, 107, 265, 343, 463, 470, 476, 481, 493, 520, 557, 617, 688
- Copernicus, Nicolas**, 462
- Corollary to Fundamental Theorem of Algebra**, 207
- correlation coefficient**, 38, 40–43, 51, 60
- coscant**, 286, 292, 295, 298, 301, 304, 311, 327, 336–337, 364, 395–403, 416, 418, 421–481, 492
- cosine**, 285–289, 291, 294–295, 299, 301, 304, 311, 336–337, 359, 364, 368, 370–371, 376, 380, 389, 393, 406–412, 415, 418, 421–481, 515, 519, 630
- cotangent**, 286, 289, 292, 295, 301, 304, 311, 336, 421–481, 492
- coterminal angles**, 279–281, 298, 304, 318, 336, 555
- cotes**, 462
- Coulombs Law**, 188
- counterexample**, 17, 308, 363, 410–411, 421–422, 427, 438, 848, 923
- Cramer's Rule**, 97
- critical points**, 164, 171, 174–175, 177, 179
maximum, 171, 173–177, 188, 197, 199, 207, 211, 228, 257, 392, 413, 469, 641
minimum, 171, 173–177, 188, 197, 199, 228, 249, 413, 469, 641
- point of inflection, 171, 174, 176–178, 199, 228, 641
- critical thinking**, 11, 12, 18, 24, 25, 30, 31, 36, 37, 43, 44, 50, 56, 72, 77, 84, 85, 95, 103, 104, 110, 118, 135, 144, 145, 150, 157, 167, 168, 178, 179, 187, 195, 211, 212, 220, 227, 228, 234, 235, 241, 248, 249, 256, 263, 282, 289, 297, 303, 310, 311, 317, 318, 325, 326, 349, 350, 356, 365, 366, 375, 385, 386, 393, 394, 402, 411, 412, 429, 435, 436, 444, 454, 455, 460, 461, 468, 469, 476, 492, 498, 504, 510, 518, 519, 525, 532, 541, 542, 559, 566, 567, 572, 573, 579, 584, 591, 597, 605, 606, 621, 629, 630, 639, 640, 651, 652, 660, 668, 676, 683, 864, 701, 702, 710, 716, 724, 731, 732, 736, 737, 746, 747, 764, 765, 772, 773, 782, 792, 799, 805, 812, 813, 820, 827, 828, 844, 845, 850, 857, 865, 866, 873, 874, 878, 880, 895, 905, 906, 915, 917, 924, 925, 932, 947, 948, 959, 968, 974
- cross products of vectors**, 505, 507–509, 511–512, 543, 545, 567, 851
- cross products of vectors in space**, 507
- cross-sectional area**, 196
- cryptography**, 158
- crystallography**, 132
- cube roots**, 191, 283, 601–602
- cubic functions**, 143, 179, 258–259, 261–263, 266, 270
- culinary arts (cooking)**, 111, 878
- cumulative frequency distribution**, 902
- currency**, 871
- current**, 165, 725
- customer service**, 715
- cycloid**, 532
- cylinders**, 210, 226



- data**, 82
analyzing, 178, 937
mean deviation, 910–911, 915–917, 919, 921–926, 928, 931–933, 935–936, 975
organizing, 84, 753
sample sets of, 927–932
standard deviations, 908, 911–912, 914–917, 919, 921–926, 928, 931–933, 935–936, 975
- decay formula**, 706, 722
- decompose fractions**, 243–244, 247–248, 394
- decreasing functions**, 84, 159, 163, 164, 167, 197, 706
- degenerate conics**, 623, 662–663, 675–676, 674, 678

- degree**
 angle measure, 210, 277–282, 290, 304, 336, 343, 553
 of polynomial functions, 206, 226, 271, 801–802
- demographics**, 31, 43, 708, 709, 714, 717
- DeMoivre, Abraham**, 462, 827
- DeMoivre's Theorem**, 290, 599–601, 603–604, 610, 827
- dependent events**, 67–68, 70–72, 86, 136, 196, 837–838
- dependent systems of equations**, 843, 883, 907
- dependent variable**, 7, 39, 742
- depressed polynomials**, 224–226, 230
- derivatives**, 951–960, 969, 975, 977
 antiderivatives, 951–960, 970, 972
 constant multiple of power rule, 953, 955–956, 971
 of polynomial functions, 952–953, 979
- dermatology**, 429
- design**, 579, 606
- disaster relief**, 866
- discrete math**, 85
- design surveys**, 896
- Descartes, René**, 231, 969
- Descartes' Rule of Signs**, 231–232, 234, 236–237
- determinants**, 98–100, 102–104, 119, 121, 179, 242, 290, 366, 376, 445, 507, 510, 560, 669, 948
- diagonals**, 331, 412, 560, 620–621
- diagrams**
 tree, 843
 Venn, 583, 863, 867, 873
- diameter**, 95, 283, 300, 303, 313, 349, 412, 623–630, 660
- difference identities**, 437–441, 444, 498, 591
- difference of two squares**, 202
- differential equation**, 584
- differentiation**, 952
- dilation**, 82, 92–93, 95, 138, 140, 145, 538–540, 591, 717
- dimensional analysis**, 353
- direction of vector**, 485, 490–491, 493, 513, 516–518, 520, 534, 543, 547, 814
- directrix of parabolas**, 653–661
- direct variation**, 189–195, 199, 298
- directed line segments**, 485, 501
- Dirichlet, Peter Gustav**, 367
- discontinuity**, 161, 283
- discontinuous functions**, 159, 162, 165, 197, 199, 429, 942
- discriminant**, 213, 215–216, 217–219, 235, 267–268, 748, 763
- displacement vectors**, 376, 461, 501, 504, 954, 965
- distance**, 61, 124, 157, 223, 248–249, 294, 300–301, 311, 452, 472, 480, 501, 558–559, 938
 between points, 615, 630
 between two parallel lines, 470, 474
 between two points in polar planes, 556
 between two points in rectangular coordinates, 556
 formula, 223, 272, 437, 559, 617, 619, 633, 643, 654
 formula in polar planes, 557
 from a point to a line, 470–471, 498, 560
- Distributive Property**, 86, 101, 581, 824
- divergent series**, 786–793, 797, 805, 821, 831, 907
- dividend**, 222
- divisibility**, 64, 196, 221
- division**,
 synthetic, 223–227, 230–231, 235, 237–238, 240, 267, 269, 351, 573
- dodecahedron**, 870
- domains**, 5–6, 8–11, 14–16, 19, 31, 46–48, 51, 57–58, 72, 111, 157, 170, 197, 201, 230, 250, 362, 396–397, 405–407, 413, 436, 665, 667, 704–706, 714, 716–717, 926
- dot product of vectors**, 506
- double-angle identities**, 449–453, 476–477, 479
- doubling time**, 740, 752
- drumlin**, 828, 867
- dynamical systems**, 580–581



- e**, 712–747, 750
- e-commerce**, 32
- eccentricity**, 640, 648–649, 651, 658, 687, 690
 for ellipses, 636–637, 639
 for hyperbolas, 650
- ecology**, 242, 366, 791, 815, 820, 867
- economics**, 25, 27, 28, 31, 37, 41, 42, 44, 236, 239, 249, 743, 774, 779, 792, 889, 913, 959
- education**, 11, 38, 39, 42, 86, 104, 117, 150, 196, 249–250, 257, 746, 805, 814, 837, 901–902, 907–912, 916, 923–925, 927–928, 975
- effective annual yield**, 715
- effective rate**, 746
- elasticity coefficient**, 376
- electricity**, 196, 249, 394, 442, 584, 590, 591, 593, 597, 611, 725, 736
- electronics**, 24, 187, 385, 402, 435, 443, 453
- elements**, 5–6, 78, 98, 119
- elevation**, 335
- elimination method**, 68, 70, 77, 106
- elliptic pool**, 639
- ellipses**, 419, 631–641, 658, 661, 663, 666, 681, 686–687, 880
 axes of symmetry, 631
 eccentricity, 636–637, 639
 graphing, 641, 661
 standard form equation, 633–634
- employment**, 43, 44, 167, 709, 930
- end behavior of functions**, 159, 162–166, 199, 499, 591, 661, 705, 926, 948
- energy**, 653, 655
- engineering**, 50, 56, 221, 256, 303, 412, 469, 683, 725, 782
- entertainment**, 84, 95, 137, 141, 220, 271, 282, 298–299, 352–354, 356, 385, 391, 394, 403, 405, 409, 456, 458, 518, 532–533, 639, 748, 765, 781, 844, 867, 894, 897, 900, 932, 936
- entomology**, 500–501, 704, 707
- epicenter**, 625
- equal**
 matrices, 79, 90, 119
 vectors, 498, 504, 543
- equations**
 of asymptotes, 180–181, 185–188, 644, 689, 783
 of circles, 687
 completing the square, 213–215
 of parabolas, 655–656
 of hyperbolas, 646, 658, 675, 687
 of parabolas, 691, 658
 parametric form, 520–527, 529–530, 542, 546, 602, 663–669, 684, 690
 quadratics, 213–215
 radical, 250, 254, 264, 267, 270
 rational, 86, 125, 243, 264, 270
 of vertical lines, 376
 normal form, 476
 polar form, 571–572, 574, 577, 588, 591, 593, 595–597, 600–601, 603–604, 606–607, 609–610, 716, 810, 932
 standard form, 21, 30, 35, 463, 465, 468, 471, 473, 523, 575, 663
 of directrix, 653, 702
 of lines, 20–21, 27–28, 30, 33, 57, 75, 196, 520, 793
 prediction, 38–39, 475
 regression lines, 41, 61
- equilateral hyperbolas**, 647, 651
- equilateral triangle**, 105, 326, 833
- equilibrium**, 515–518
- equilibrium point**, 365, 391
- equivalent equations**, 129–130, 542, 627
- Eratosthenes**, 534
- escape set**, 599, 603, 605, 819

- estimating**, 194, 272, 612, 660, 683, 744–745, 974
- Euclid**, 319
- Euler, Leonhard**, 367, 462, 807
- Euler number**, 807
- Euler's formula**, 806, 809–810, 829, 832
- even degree**, 208
- even functions**, 133, 145, 163, 166, 197, 732
- event**
 dependent, 67–68, 70–72, 86, 136, 196, 837–838
 independent, 837–838, 870, 874, 881
 mutually exclusive, 861–863, 867, 881, 884
 mutually inclusive, 862, 867
- everywhere discontinuous**, 159
- excluded value**, 8, 11
- expansion by minors**, 98, 507
- experimental probabilities**, 877–878
- exponential**
 decay, 706, 708, 714
 equations, 716, 749
 form, 810
 functions, 704–706, 710, 719, 729, 741–745, 749–750, 793
 growth, 706–708, 714, 749
 inequalities, 707
 models, 744
 regression, 739, 747
 series, 806, 812
- exponents**, 51, 64, 206, 445, 613
 integral, 695
 properties of, 64, 124
 rational, 698–700, 717, 750, 753
- extraneous solutions**, 251–255, 267, 271
- extrema**, 171, 176, 199, 499
- extreme values**, 910, 918
- F**
- factor**
 polynomials, 64, 202, 208–211, 214, 217–218, 226–227, 250, 252, 268, 366, 431, 456–457, 570, 626, 635, 641, 656, 721, 769, 824, 952
 theorem, 224, 226, 233, 267–268
- factorial notation**, 797, 803
- failures**, 852, 881, 883
- families of graphs**, 26, 57, 137, 139, 151, 178
 circles, 629
 ellipses, 641
- Fahrenheit temperatures**, 17, 152
- favorable outcomes**, 886
- Fermat, Pierre**, 969
- Fermat's method**, 969
- Fibonacci sequences**, 784, 806, 813
- Fibonacci's spiral**, 806
- finance**, 19, 33, 61, 77, 85, 154, 675, 707, 710, 713, 714, 716, 724, 725, 737, 793, 805, 878
- finite arithmetic series**, 761
- finite geometric sequence**, 769, 771
- finite geometric series**, 770
- finite graphs**, 85
- foci**, 880, 975
 of ellipses, 631–641, 687, 765
 of hyperbolas, 642–652, 783
 of parabolas, 653–661
- fire fighting**, 157, 303, 326
- flywheels**, 282
- food**, 519, 533, 703, 850, 917
- force of attraction or repulsion**, 188
- focus-directrix definition**, 658
- forestry**, 194, 652, 717
- formulas for**
 acceleration, 76
 area, 867
 area of circular sectors, 347
 changing degrees Celsius to Kelvin, 17
 changing degrees Fahrenheit to degrees Celsius, 17
 circumference, 612
 compound interest, 205, 769, 812
 computing binomial probabilities, 817
 Coulomb's Law, 188
 current speed, 187
 depreciation, 24
 distance a golf ball travels, 519
 distance of free falling bodies, 242
 distance traveled, 223
 distance traveled by free falling objects, 220
 distance traveled by radio waves, 11
 emissivity of objects, 429
 exponential growth or decay, 712
 future values, 710
 future values of annuities, 716
 gravitational potential energy, 166
 illuminance, 434
 infinite geometric series, 795
 intensity of earthquakes, 730
 intensity of light, 195
 interest rate, 156
 kinetic energy of a particle, 157
 light exposure in a camera, 724
 linear velocity, 354
 maximum height of projectiles, 481
 mutually exclusive events, 862
 Newton's Law of Universal Gravitation, 196
 n th term of arithmetic sequences, 760, 796
 n th term of geometric sequences, 767
 ocean depth, 111
 period of oscillating pendulums, 271
 period of pendulums, 256, 476
 population of bacteria, 167
 products of complex numbers, 599
 simple interest, 19
 slope, 949
 strength of magnetic fields, 427
 temperature of atmosphere, 11
 tensile stress, 256
 time it takes an object at rest to fall a distance, 255
 volume of cones, 193
 volume of rectangular prisms, 229
 volume of spheres, 701
 work of a person displacing a box, 18
- Fourier, Jean**, 367
- fractal geometry**, 586–587, 599, 605, 817–818, 820
 Julia sets, 599, 604, 818–819
- fractions**
 decomposing, 243–247
 partial, 248, 677
 rational expression, 181, 197, 243, 248
- frequency**, 372–373, 376, 413, 901
 chart, 906
 distributions, 889–892, 901, 904–906, 913, 931
 polygons, 892, 895, 918
 tables, 907, 938
- friction**, 297, 716
- Frisicus, Gemma**, 534
- function**, 5–6, 9–12, 19, 25, 31, 37, 51, 57, 61, 179, 365, 367, 377, 436, 560, 684, 714, 717, 968
 antiderivatives, 951–960, 970, 972
 arccosine, 306, 335, 406–412, 416, 703
 arcsine, 306, 335, 406–412, 416
 arctangent, 305, 406–412, 416
 circular, 292, 335
 composition of, 14–15, 17–18, 25, 31, 37, 44, 58, 61, 104, 151, 155, 445, 720
 compound, 382
 constant, 22, 137, 164, 953
 consumption, 44, 50
 continuous, 159–162, 165–166, 168, 179, 197, 199, 283, 430, 706, 782–783, 821, 942, 970
 cosecant, 286, 292, 295, 298, 301, 304, 311, 336–337, 364, 395–403, 416, 418, 421–481, 492
 cosine, 285–289, 291, 294–295, 299, 301, 304, 311, 336–337, 359, 364, 368, 370–371, 376, 380, 389, 393, 406–412, 415, 418, 421–481, 515, 519, 630
 cotangent, 286, 289, 292, 295, 301, 304, 311, 336, 421–481, 492
 decreasing, 84, 159, 163, 164, 167, 197, 706
 derivatives of, 952
 discontinuous, 159, 162, 165, 197, 199, 429, 942
 domain, 5–6, 8–11, 14–16, 19, 31, 46–48, 51, 57–58, 72, 111, 157, 170, 197, 201, 230, 250, 362, 396–397, 405–407, 413, 436, 665, 667, 704–706, 714, 716–717, 926
 even, 133, 145, 163, 166, 197, 732

exponential, 704–706, 710, 719, 729, 741–745, 749–450, 793
 graphing, 200, 211, 242, 365, 373, 377, 379–381, 384–386, 390, 394, 400–401, 416–417, 659, 709, 713
 increasing, 164
 infinite discontinuity, 159, 165–166, 257, 283, 821
 integral of, 166
 inverse, 152, 154–156, 221, 525, 585, 718
 iterates of, 580, 604
 jump discontinuity, 159, 161, 165–166, 821
 linear, 22, 24–25, 45, 183, 258, 262, 746
 logarithmic, 718–719, 727–728, 737, 741, 744–745, 749
 notation, 7
 odd, 133, 135, 163, 166, 732
 operations with, 13, 58
 periodic functions, 360
 phase shift, 378–379, 381–383, 389, 394, 398–402, 412–413, 417, 446, 498, 641, 845, 925
 point discontinuity, 159–160, 165–166, 169, 184–185, 187, 197, 257, 283
 pole, 180
 polynomial, 137, 151, 156, 162, 164–167, 170, 172–173, 176, 179–180, 182, 197–199, 206, 210, 222, 231, 233, 236, 258–262, 265–267, 269–271, 585, 980
 quadratic, 137, 140–143, 160, 164, 168, 170, 176, 198, 215, 258, 260, 261–262, 298
 radical, 8, 11, 143, 156, 198
 range, 5–6, 8–9, 15, 19, 31, 47–48, 51, 57, 72, 111, 149, 157, 201, 395–397, 405, 407, 436, 705–706, 714, 716–717, 890–891, 893–895, 908, 926, 929, 933–934, 948
 rational, 11, 137, 180, 182, 184, 186–187, 196–199
 secant, 167, 188, 286, 292, 295, 301, 311, 336–337, 364, 395–403, 416, 418, 421–481
 sine, 285–289, 291, 294–295, 298–299, 301, 303, 311, 336–337, 359, 361, 364, 368, 370, 377, 389, 385, 389, 391, 406, 412, 415, 418, 421–481, 515, 519
 step, 46, 50, 60, 104, 143, 156, 162, 166, 168, 198
 table, 138, 141, 152, 160–161, 175, 184, 199, 295, 362, 704
 tangent, 171, 188, 285–289, 292, 295, 299, 301, 304, 311, 334, 336–337, 395–403, 406–412, 416, 418, 421–481, 492, 684
 trigonometric, 293, 295–298, 301, 304, 318, 337, 382, 425, 428, 431, 434–436, 702
 undefined, 399
 vertical displacement, 365, 528
 vertical line test, 7–8, 25
 zeros of, 22–23, 24–25, 57, 86, 206, 232, 271, 378, 498

Fundamental Theorem of Algebra, 205, 207
 corollary to, 207
Fundamental Theorem of Calculus, 970–977, 980
fund-raising, 111, 145, 377, 917



games, 95, 795
gap discontinuity, 169–170
gardening, 271, 579, 682, 691
Gauss, Carl Friedrich, 97
gears, 325
gemology, 461
general form, 409
 of circles, 625–627, 687
 of conic sections, 662, 667
 of hyperbolas, 646, 687
 of parabolas, 655–656
 of parametric equations, 521
 of sequences, 775
 of series, 797
 of sinusoidal functions, 388
geography, 11, 281, 346, 350, 410, 455, 895, 915
geology, 828, 867
geometry, 35, 36, 71, 104, 110, 123, 135, 144, 145, 179, 187, 192, 210, 226, 228, 233, 300, 302–303, 310, 316, 326, 331, 357, 394, 412, 429, 436, 461, 468, 476, 492, 498, 510, 525, 541, 621, 629, 640, 661, 732, 764, 782, 833, 845, 850, 880, 947–948, 975
geometric means, 766, 768, 772, 793, 829
geometric sequences, 766–769, 771–773, 783, 793, 800, 830, 960
 common ratios, 764–770, 783, 795, 829–830, 960
 geometric means, 766, 768, 772, 793, 829
 n th term, 760
geometric series, 769, 778, 830
girth, 109
golden ratio, 784, 813
goodness of fit, 38, 40
government, 905, 916
graphical iteration, 586–587, 589, 599, 604, 607
graphing
 absolute value inequalities, 221
 absolute value, 72, 86, 118, 386
 asymptotes, 645–646
 boundaries, 54, 146
 catenary curves, 715
 circles, 623, 669
 complex numbers, 586–589
 compound functions, 378, 382
 conic sections, 623–691
 constant functions, 46

dilations, 93
 ellipses, 641, 661
 even functions, 134
 exponential functions, 708, 718
 functions, 365, 373, 377, 379–381, 384–385, 390, 394, 400–401, 416–417, 659, 709, 713
 geometric transformations, 539
 greatest integer functions, 677
 inequalities, 52–53, 55–56, 60, 72, 77, 111, 146, 149–151, 179, 198, 358, 708, 722
 inverses, 22, 24, 48–50, 56, 133, 156, 165, 177, 183, 199, 221, 298, 405, 455, 684
 lines, 20, 31, 37, 59, 455, 521, 524, 874
 logarithmic functions, 718
 orbits, 818
 ordered pairs, 10, 561, 576, 635
 parabolas, 656
 parametric equations, 525, 665
 piecewise functions, 45, 170, 377
 polar equations, 552–557, 561–565, 573–574, 578–579, 584, 608, 677
 polygonal convex regions, 111
 rational functions, 200, 242, 386
 relations, 131
 statistical
 back-to-back bar graph, 889
 bar, 889, 924, 934, 937
 circle graphs, 857, 938
 cumulative frequency, 902
 cumulative frequency distribution, 902
 frequency polygons, 892, 895, 918
 histograms, 890, 892, 933–934, 938
 scatter plots, 38, 41–42, 51, 60, 145, 151, 258–263, 270, 351, 592, 741, 744–745, 747
 stem-and-leaf plot, 899–900, 903–904, 917, 938
 step functions, 104
 systems of equations and inequalities, 107, 112–116, 122, 681–685, 690, 702, 773, 874, 907
 translations, 88, 92–94, 104–119, 137–140, 142, 145, 540, 618
 trigonometric functions, 429, 469, 573
Graphing Calculator
 Appendix, A2–A25
 Exercises, 11, 103, 143, 166, 177, 211, 262, 289, 364, 374, 435, 460, 524, 566, 605, 628, 639, 676, 709, 730, 731, 735, 798, 879, 915, 947
 Exploration, 13, 69, 86, 106, 133, 232, 265, 284, 323, 333, 369, 378, 404, 433, 458, 512, 526, 592, 602, 641, 665, 685, 695, 705, 738, 784, 809, 877, 926, 945, 949
 Tips, 46, 67, 99, 138, 153, 164, 173, 181, 206, 225, 238, 253, 259, 278, 286, 328, 372, 389, 564, 576, 581, 625, 635, 645, 655, 679, 699, 713, 727, 742, 909, 911, 944
gravitational potential energy, 166
gravity, 289, 291

greatest common factors, 646, 656
greatest integer function, 46, 48, 50,
 60, 137, 139, 156, 166, 170
growth formulas, 706, 712



half angle-identities, 451–454, 477,
 479, 606, 783
half-life, 718, 722, 737
half planes, 52, 53
harmonic means, 249, 772
harmonic series, 792
health, 212, 383, 389, 391, 724, 813,
 860, 892, 924
height, 76, 226
Herigone, Pierre, 319
Hero's Formula, 330
hertz, 372
Hipparchus, 462
histograms, 890, 892, 933–934, 938
history, 468, 639, 786, 790, 827, 893
History of Mathematics, 97, 319, 367,
 462, 534, 969
Holloway, Dennis, 462
horizontal asymptotes, 180–184,
 186–187, 200, 436, 492, 705–706, 728
horizontal line test, 153, 158, 718
hyperbolas, 419, 642, 658, 661, 663,
 672, 682–683, 687, 783
 asymptotes, 642–652
 axes of symmetry, 137, 653–661,
 691
 conjugate axes, 642–652
 eccentricity for, 650
 foci, 642–652, 783
 graph, 419, 642, 658, 661, 663, 672,
 682–683, 687, 783
 standard form, 643, 647
 transverse axes, 642–652
hyperboloid, 651
hypotenuse, 284, 299, 307, 340



i, 809
Ideal Gas Law, 186
identities, trigonometric 421–481, 594,
 664–665
 double-angle, 449–453, 476–477,
 479
 half-angle, 451–454, 477, 479, 606,
 783
 Pythagorean, 421, 423, 426, 432,
 440, 457, 478, 570
 quotient, 421–423, 425, 432,
 477–478

reciprocal, 286, 421–423, 426, 441,
 452, 477–478
 reduction, 446–447
 sum and difference, 438–439, 441,
 448–449, 477, 498, 591
 symmetry, 421, 424–425, 439,
 477–478
also see inside back cover
identity matrices, 99–100
image, 88–89, 91–95, 142, 196
imaginary numbers, 206, 214, 268,
 581, 604, 699
 pure, 206, 209, 581, 583, 607
imaginary roots, 216, 220, 235, 376,
 911
imaginary unit (*i*), 809
impedance, 584, 591, 725
inclusive events, 862
inconsistent systems of equations,
 67–68, 70–72, 86, 119, 136, 196
increasing functions, 164
indefinite integrals, 970–971, 980
independent events, 837–838, 870,
 874, 881
independent system of equations,
 67–68, 70–72, 86, 136, 196, 843, 883,
 907
independent variable, 7, 39, 522, 581,
 741–742
index of refraction, 284, 286, 289, 311,
 444, 461, 821
index of summation, 794–797
indirect variation, 194, 648
industry, 103, 925
inequalities,
 linear, 16, 56, 64, 149, 169, 188, 250
 exponential, 707–708
 quadratic, 504
 radical, 150, 198, 253, 270
infeasibility, 113, 115–117
inflection point, 175
inferential statistics, 927, 933
infinite discontinuity, 159, 165–166,
 257, 283, 821
infinite sequences, 774–778, 829
infinite series, 778, 780, 786, 790–791,
 795, 831
infinity, 162, 499
initial velocity, 76–77, 220, 223, 242,
 255, 291, 529, 532–533, 547, 845, 976
inner products, 505, 508, 510, 519,
 525, 543, 544, 560, 765
inner products of vectors, 506, 652,
 711
inscribed, 105, 300
 angles, 313, 317, 476, 612
 polygons, 969
integral, 961
 coefficients, 229
 exponents, 695
 power of ***i***, 583

powers of ten, 726
 Root Theorem, 230, 233, 267
 upper bound, 351
integration, 962, 977
intensity of light, 297
iterate functions, 832
intercept, 30
intercepted arcs, 345, 348–349, 376,
 414
interest, 19, 101, 117
 compounded continuously, 714,
 813, 975
 income, 124
 rate, 19, 156, 205, 710, 746
interior angles, 319, 612
interior design, 212
interior regions of conics, 684
Internet Connections, 10, 12, 30, 57,
 65, 84, 97, 105, 119, 125, 133, 136,
 167, 197, 203, 221, 226, 263, 267, 273,
 283, 312, 319, 331, 333, 335, 341, 357,
 358, 367, 388, 413, 455, 470, 477, 483,
 499, 512, 534, 543, 549, 582, 598, 604,
 607, 613, 620, 622, 628, 687, 693, 703,
 710, 741, 749, 755, 784, 800, 813, 829,
 835, 851, 881, 895, 896, 906, 908, 933,
 939, 943, 956, 961, 969, 970, 976, 977,
 983
Internet Projects, 61, 123, 201, 271,
 339, 417, 481, 547, 611, 691, 753, 833,
 885, 937, 981
interpolation, 902
interquartile range, 909–910,
 914–916, 925, 935
intervals, 239, 245–246, 253–254, 283,
 366, 394–395, 412, 895
inverse
 cosine functions, 429
 functions, 152, 154–156, 167–168,
 188, 196, 221, 386, 525, 585, 718
 of coefficient matrices, 100
 of exponential functions, 718
 of logarithmic functions, 729
 of matrices, 97–98, 100, 103, 151,
 179, 212, 671
 relations, 197
 of trigonometric functions,
 305–306, 405–406, 409, 560, 570,
 669
 variation, 191–193, 195, 200, 283,
 677
inversely proportional, 191
investments, 98, 101, 117, 124, 205,
 242, 710, 740, 770–771, 812–813, 907
irrational exponents, 699
irrational numbers, 106, 206, 705,
 712, 807
e, 712–747, 750
pi, 548
isosceles trapezoids, 621

isosceles triangles, 71, 302, 483, 516, 619–621, 661
iteration, 16–18, 580–589, 604–605, 815–821, 917



Jiuzhang, 97
joint variation, 192–195, 197, 200, 598, 669
Julia, Gaston
Julia sets, 599, 604, 818–819
jump discontinuity, 159, 161, 165–166, 821



Kelvin, 17
Kepler, Johannes, 969
Keplers' Third Law, 753
kinetic energy, 157, 981
Korich, Mark, 534



Lagrangi, Joseph, 367
Lambert, 462
landscaping, 317, 621, 858, 875–857
latitude, 278, 282, 290, 410
latus rectum, 660
Law of Cosines, 327–330, 335, 338, 437, 510, 516, 557
Law of Sines, 313–318, 321–322, 324, 327–328, 335, 338, 516
leading coefficients, 206, 209–210, 214, 230
least common denominator (LCD), 243–244, 248
leaves, 899, 900
Leibniz, Gottfried, 97, 969
lemniscate, 564–566
level of confidence, 929–930
limaçon, 562, 564–566, 607–608, 611
limits, 775, 829, 921, 941–948, 962
 of constants, 776
 of continuous functions, 981
 of differences, 776
 of products, 776, 788
 of quotients, 776
 of sequences, 780
 of slope, 952
 of sums, 776
Limit Theorems, 777–778, 963

linear functions, 20–28, 30, 33, 45, 57, 75, 183, 196, 258, 262, 746, 793
 graph, 20, 37, 59, 242
 point-slope form, 28, 29, 34–35, 39, 57, 59, 453–454
 slope intercept form, 21–22, 26–27, 29, 32, 37, 56–57, 59, 67, 86, 104, 109, 136, 158, 196, 290, 463, 471, 473, 522–523
 standard form of, 463
linear inequalities, 52
 graphing, 52, 60, 146
linear programming, 112–113, 115, 122, 158
 alternate optimal solutions, 114–117
 constraints, 112–113, 115
 infeasibility, 113, 115–117
 unbounded, 113, 116–117
linear regression, 41, 743
linear velocity, 353–357, 377, 386, 413–414, 591, 684, 711, 814
linearize data, 740, 743, 747, 749
line graphs, 938
line plots, 167, 889
line segments, 35, 490, 621, 835
line symmetry, 129, 134, 137, 158
lines, 419
 best-fit, 38, 40–41, 51, 60, 258–259, 270, 593
 distance between parallel lines, 470, 474
 normal, 463, 477
 tangent to circles, 429
Location Principle, 236, 239
logarithmic functions, 718–719, 727–728, 737, 741, 744–745, 749
logarithmic model, 742
logarithms, 718, 720, 724, 891, 896
 antilogarithms, 726, 729, 734, 748, 751
 characteristic, 727, 730
 common, 726–728, 737, 749, 751
 equations, 718–719, 727–728, 737, 741, 744–745, 749
 mantissa, 727, 749
 natural, 733–735, 739, 749, 752, 811
longitude lines, 278, 282
lower bound, 238–241, 267, 351, 498
Lower Bound Theorem, 239–241, 351



magnitude, 485, 488–489, 491, 493–97, 501–505, 508, 511–518, 534, 543–544, 547, 567, 583, 590–591, 622, 702, 814, 880, 943
major axes, 631–641, 671, 687, 948
mantissa, 727, 749
manufacturing, 48, 49, 55, 72, 77, 112–113, 115, 117, 118, 123, 135,

149, 178, 179, 201, 227, 234, 235, 240, 250, 283, 298, 376, 436, 469, 492, 606, 677, 794–795, 851, 873, 968

marginal cost function, 958, 967
marine biology, 541
marketing, 212, 263, 716, 846, 852
mass, 157, 166
mathematical induction, 822–829, 832
matrices, 78–81, 84–87, 90, 104, 145, 168, 179, 188, 265–266, 298, 386, 494, 510, 535, 537, 541–542, 546, addition, 96, 179
 augmented, 106
 column, 78
 determinants, 98–100, 102–104, 119, 121, 179, 242, 290, 366, 376, 445, 507, 510, 560, 669, 948
 dimensions, 71, 78–79, 119, 220, 240
 elements, 5–6, 78, 98, 119
 equal, 79, 90, 119
 equations, 84, 100–101, 122, 145, 158, 717
 inverses, 97–98, 103, 151, 212
 $m \times n$ matrix, 78
 multiplicative inverse, 100, 102
 multiplying, 85, 123, 136, 250, 671
 nonsingular, 98, 102
 operations, 535, 546
 row, 78
 scalar product, 80, 496
 square, 78, 99
 subtraction, 80, 120
maximum, 171, 173–177, 188, 197, 199, 207, 211, 228, 257, 392, 413, 469, 641
 area, 628
 height, 104, 137, 157, 201, 250, 252, 291–292, 391, 452, 454, 657, 659, 711, 798, 951, 954–955, 959
 income, 867
 profit, 111–112, 114, 117–118, 120, 123, 135, 176, 228, 436, 606, 630, 748
 revenue, 115
 speed, 559
 values of functions, 108, 175, 748
 volume, 178, 968
mean, 50, 111, 150, 661, 715, 897–900, 903–907, 914, 916–917, 920–921, 923, 925, 934, 937, 939, 943
 average temperature, 392, 417
 data in frequency distribution, 931
 geometric, 766, 768, 772, 793, 829
 standard error of, 927–928, 930–933, 936
mean deviations of data, 910–911, 915–917, 932, 935
measure
 of angles, 277, 291, 307, 350, 755, 809
 of sides of right triangles, 337
measures of central tendency, 897–908, 933, *see mean, median, mode*
measures of variability, 908–917
 see range, standard deviations, variance

mechanic, 326, 349–350, 377, 509, 591, 684, 711

median, 44, 619, 897–900, 903–907, 910, 914–917, 925, 933–934, 937, 939 class, 902
class of frequency distribution, 906
of trapezoids, 618–619

medicine, 241, 271, 493, 495, 542, 631–632, 712–713, 736, 782, 866, 868, 871, 879, 919–920

Menelaus, 462

meteorology, 5, 152, 209, 318, 359, 361, 363, 365, 387–388, 391–392, 393–394, 411, 417, 531, 541, 622, 702, 724, 725, 735, 773, 856, 857, 865, 905, 914

midline, 380, 389, 398

midpoint, 35, 105, 228, 242, 272, 519, 618, 620, 642, 661, 652, 688
formula, 272, 618–619

military science, 112, 879

minimum, 108, 171, 173–177, 188, 197, 199, 228, 249, 413, 469, 504, 641, 657, 732, 748

minor arcs, 612

minor axes, 631–641, 671, 948

minor of an element, 98

minutes, 277–278, 280–282, 290, 304, 335–336

mixture problems, 107, 124, 606

mode, 897, 899–900, 903–906, 917, 925, 934, 937

modeling data
exponential and logarithmic, 706, 712, 740–748
linear, 38–44
linearizing data, 740–748
matrices, 78–96
polynomial, 258–264
parametric equations, 527–535
polar equations, 565–566
sinusoidal, 387–394

moduli of complex numbers, 587–588, 594–595, 604, 607

monotonicity, 163, 167, 197

motion, 641, 958

multiplication, 151, 421
of binomials, 581
of complex numbers in rectangular form, 580–585, 609, 630
of exponents, 136
of expressions, 431
of functions, 14, 17–18, 31, 58
of matrices, 82, 119–120
of rational expressions, 273

multiplicative inverse, 103, 111, 121, 151, 248, 298
of matrices, 100, 102

music, 84, 257, 372, 375, 386, 391, 461, 566

mutually exclusive events, 861–863, 867, 881, 884

mutually inclusive events, 862, 867



national landmarks, 304, 309

natural logarithms, 733–735, 739, 749, 752, 811

natural numbers, 206

nature of roots, 215, 235

navigation, 249, 277–278, 325, 339, 474, 481, 489, 525, 611, 642, 646, 783, 793, 874

net, 227, 983

Newton, Isaac, 969

Newton's gravitational constant, 166,

Newton's Law of Cooling, 714, 736, 960

***n*-gon**, 88

nodes, 85

noncollinear points, 498, 592, 626

nonincluded angle, 313, 339

nonlinear inequalities, 148

nonlinear model, 741

nonlinear regression, 741, 749

nonsingular matrices, 98, 102

normal, 463, 465–466
curve, 918
distribution, 918–925
distribution curve, 935
form, 464, 467, 470, 511, 574–575, 737
form of equations, 476
form of linear equations, 463
lines, 463, 477
segments, 466, 479, 578

normally distributed data, 921–925

***n*th factorial**, 796, 829

***n*th order**, 78, 99

***n*th order determinant**, 98

***n*th partial sum**, 761

***n*th root**, 697

***n*th root equations**, 252

***n*th term**, 767, 773, 778

***n*th term of geometric sequences**, 760

nuclear power, 651, 821

number patterns, 827

number theory, 77, 805, 813–814, 826, 828

nutrition, 40, 52, 54, 403, 894, 925, 959



odd functions, 133, 135, 163, 166, 732

odds, 125, 341, 854–857, 883

opposite-angle identities, 421, 426–428, 477–478

opposite vectors, 487, 498, 725

optics, 248, 421, 426, 428, 444, 460, 470, 473, 821

optimal solutions, 114

optimization, 171

orbit complex numbers under iterations, 819

ordered triples, 74, 77, 500–503, 511, 519, 544, 585, 622, 702, 968

ordinate, 5, 21, 47, 382

oscillation, 392

Oughtred, William, 319

outcomes, 843, 869, 877, 886

outliers, 909, 914–916



***p* distinct roots of complex numbers**, 601–602

***p* distinct roots of positive real numbers**, 606

pH, 726

parabolas, 140–141, 160, 190, 198, 419, 653–661, 663–664, 669, 682, 687, 698, 702, 967
axis of symmetry, 653–661
latus rectum, 660
standard form equation, 660
vertices of, 653–661, 667

parabolic arc, 532

parallax of stellar objects, 731

parallel, 26, 32, 34–37, 51, 57–59, 61, 67, 109, 114, 158, 179, 212, 228, 410, 480, 488, 520, 613, 983

parallelepiped, 510, 538, 541

parallel resistors, 249

parallel vectors, 498, 523, 543, 547, 725

parallelogram method, 486–487, 491, 544

parallelograms, 36, 273, 316, 482, 491, 500, 512, 538, 549, 613, 617, 620–621, 640–641, 725, 874, 887, 948

parameter, 520–521, 543, 867

parametric equations, 520–527, 529–530, 542, 546, 602, 663–669, 684–685, 690

parent function, 137–147, 151, 154, 156, 164, 180, 182, 186–187, 198–201, 228, 283, 368, 380, 624, 631, 643, 670, 705–706, 709, 711, 728

partial fractions, 248, 677

partial sums, 786, 790

Pascal's triangle, 801–802, 804, 813

Pearson Product-Moment Correlation, 40–41, 403

pendulum, 348–349, 375

pentagon, 94, 300, 311, 316

- percent**, 20, 179, 283, 341, 606, 799, 835, 937, 939, 947
- perfect square**, 219
- perfect square trinomial**, 202, 214,
- perimeter**, 71, 303, 316, 341, 366, 548–549, 833
of hexagons, 303
of pentagons, 302
of rectangles, 188, 358, 366, 598, 828, 968
of squares, 105, 598, 782
of triangles, 105, 123, 326, 498, 661, 907, 983
- periodic functions**, 359–360, 363, 365, 395, 456
- periods**, 361–362, 365, 368–376, 378, 381–382, 385, 388–389, 393–394, 396–402, 412–413, 415–416, 498, 504, 560, 641, 968
of pendulums, 256, 376, 476
of sinusoidal functions, 391
- Permutation Formula**, 839
- permutations**, 837–851, 881–882, 885–886
circular, 847–851, 867
with repetitions, 846–851, 881
- perpendicular**, 34–36, 59, 61, 158, 179, 212, 326, 341, 463, 491, 510, 519
bisector, 35, 621
components, 488
lines, 24, 34, 59, 483
segments, 291
vectors, 505, 519, 525, 547, 560, 566, 711
- pharmacology**, 127, 146, 148
- phase angle**, 411
- phase difference**, 385
- phase shift**, 378–379, 381–383, 389, 394, 398–402, 412–413, 417, 446, 498, 641, 845, 925
- phasor notation**, 573
- phons**, 746
- photography**, 445, 724, 874
- physics**, 18, 76, 77, 93, 135, 157, 166, 179, 188, 195, 242, 255–256, 271, 284, 286, 288–289, 297, 311, 349, 357, 365, 375–376, 402, 411, 417, 429, 435, 454, 459–460, 476, 481, 492, 503–504, 510, 518–519, 532, 542, 547, 584, 622, 706, 714, 716, 782, 814, 833, 880, 941, 948, 974, 981
- physiology**, 509, 568, 569
- pi (π)**, 548
- piecewise function**, 45–48, 60–61, 132, 161, 170, 196, 199
- plane geometry**, 618
- planes**, 509
intersecting, 73–74, 500, 623
perpendicular, 500
- plot**
box-and-whisker, 908–910, 914–915, 933
line, 167, 889
stem-and-leaf, , 899–900, 903–904, 917, 938
- plug-in strategy**, 124, 202
- point discontinuity of functions**, 159–160, 165–166, 169, 184–185, 187, 197, 257, 283, 821
- points**, 86, 158
critical, 164, 171–179
escape, 818
of inflection, 171–178, 199, 228, 641
maximum, 171–177, 188, 197, 199, 207, 211, 228, 257, 392, 413, 469, 641
minimum, 171–177, 188, 197, 199, 228, 249, 413, 469, 641
prisoner, 818–819, 827
relative maximum, 172–174, 176–177, 179, 199, 201
relative minimum, 172–174, 176–177, 199, 201, 225
- point-slope form of linear equations**, 28–29, 34–35, 39, 57, 59, 463–454
- point symmetry**, 127
- polar coordinate system**, 553, 556, 568
graphing polar functions, 556, 562, 579, 661, 948
polar axis, 553, 554, 568, 588
polar coordinates, 553, 555–556, 559, 564, 567–568, 570–574, 576–579, 607, 611, 652, 737
polar inequalities, 558
- polar distance formula**, 557
- polar equations**, 556, 562, 567, 579, 948
- polar form**, 571–572, 574, 577, 588, 591, 593, 595–597, 600–601, 603–604, 606–607, 609–610, 716, 810, 932
of complex numbers, 588
of rectangular coordinates, 570
- phasors**, 573
- polarized filter**, 297
- polarized light**, 297
- pole of rational function**, 180
- poles**, 553, 555, 568
- polygonal convex set**, 107–110, 114, 118–119, 122–123, 168, 188, 469, 585, 748, 821
- polygonal regions**, 535
- polygons**, 88, 109, 112, 122, 516, 618
- polyhedra**, 535
- polynomial**, 224, 227, 250, 268, 366, 641, 809, 880
curves, 969
division, 183–184
equation, 206–209, 213, 229, 239, 603
functions, 137, 151, 156, 162, 164–167, 170, 172–173, 176, 179–180, 182, 197–199, 206, 210, 222, 231, 233, 236, 258–262, 265–267, 269–271, 585, 980
inequalities, 146–147, 149–150, 179
- population**, 241, 707, 709, 741, 742, 747, 753, 893, 927, 933, 947
- possible outcomes**, 886
- postal service**, 49, 159, 162, 843
- power**
function, 704, 708, 747
of complex numbers, 599
of complex numbers written in polar forms, 827
of power rules, 136, 697
of products, 696–699
property, 722
property of logarithms, 722
rule, 953, 955, 971
rule for antiderivatives, 957
rule for derivatives, 959
- prediction equation models**, 38–39, 475, 717, 742, 956
- pre-image**, 88–89, 91–95, 142
- prime**, 983
factors, 65, 233, 983
integers, 755, 805
numbers, 64
- principle roots**, 601, 605
- prism**, 538
- prisoner points**, 818–819, 827
- prisoner set**, 599, 603, 605, 607, 819
- probability**, 716, 852–858, 881, 884, 886, 924, 936, 948, 957, 975
binomial experiments, 876, 878, 924
complements, 853
conditional, 868–874
of compound events, 859–867
of dependent events, 67–68, 70–72, 86, 136, 196, 837–838, 843, 883, 907
of failure, 852, 881, 883
of inclusive events, 862
of independent events, 837–838, 870, 874, 881
of mutually exclusive events, 861–863, 867, 881, 884
of mutually inclusive events, 862
of two events, 859–860
odds, 125, 341, 854–857, 883
- product**
of functions, 13–14
of complex numbers, 606
of complex numbers in polar form, 593–598, 610
of consecutive integers, 796
of matrices, 81, 257
property, 699, 720–721, 727
property of exponents, 744
- projectiles**, 527–529, 531–532
- proofs**, 94, 510, 724
by mathematical induction, 822–828
addition of vectors is associative, 498
analytically, 621
DeMoivre’s Theorem, 827
properties of divisibility, 823

quotient properties of logarithms, 724
 summation formulas, 823
 sums of first n triangular numbers can be found using formulas, 826
 validity of mathematical statements, 832

properties

of addition, 86
 of exponents, 64, 124
 of inequalities, 228
 of logarithms, 720
 of multiplication, 86
 of parallel and perpendicular lines, 34
 of proportion, 692,
 of real numbers, 86

proportions, 191, 345, 692

Ptolemy, 462, 534

pulley, 504

pure imaginary numbers, 206, 209, 581, 583, 607

Pythagorean

identities, 421, 423, 426, 432, 440, 457, 478, 570,
 Theorem, 272, 286, 291, 294, 306, 327, 335, 340, 423, 477, 489, 493, 505, 510, 586, 615–616, 624, 632, 782
 triples, 340



quadrant, 277, 279, 282, 295, 297, 304, 337, 351, 424

quadrantal angles, 278, 446

quadratic

equations, 137, 213–215, 217, 231, 267, 584, 597, 755
 formula, 215–219, 230, 235, 261, 267–268, 298, 674, 676,
 functions, 137, 140–143, 160, 164, 168, 170, 176, 198, 215, 258, 260, 261–262, 298,
 graphing, 140–141, 160, 190, 198, 419, 653–661, 663–664, 669, 682, 687, 698, 702, 967
 inequalities, 504,
 polynomial functions, 263

quadrilateral, 36, 89, 93–94, 123, 340, 498, 612, 617, 620–621, 640

quality control, 885, 932

quartiles, 909, 914, 916

quotient, 222, 224, 238, 286, 594–595
 identities, 421–423, 425, 432, 477–478

of complex numbers in polar form, 593–598, 610

of functions, 13–14

of complex numbers

property, 696, 698, 720



radian measure, 343–344, 348, 413, 534

radian mode, 378, 532,

radical

equations, 250, 254, 264, 267, 270
 expressions, 250, 785
 functions, 8, 11, 143, 156, 198, 251–258
 graphing, 137, 146, 251–257
 inequalities, 150, 198, 253, 270
 simplifying, 62, 72, 250, 717, 732, 785

radicand, 8, 215

radioactivity, 725, 744–745

radius, 105, 192, 210, 226, 289, 293, 298, 300, 302, 311, 316–317, 325, 335, 349, 357, 377, 413, 417, 476, 532, 548, 622–630, 684, 805

random sample, 858, 869, 879, 883–885, 927, 931, 936, 948

range, 5–6, 8–9, 15, 19, 31, 47–48, 51, 57, 72, 111, 149, 157, 201, 395–397, 405, 407, 436, 705–706, 714, 716–717, 890–891, 893–895, 908, 926, 929, 933–934, 948

rate, 124, 540, 938

of change, 977

of increase, 31

ratio, 141, 191, 248, 284–285, 290, 294, 506, 692–693

ratio test, 787–791, 805, 829, 831, 907

rational

equations, 86, 125, 243, 264, 270
 exponents, 698–700, 717, 750, 753
 expression, 181, 197, 243, 248
 functions, 11, 137, 180, 182, 184, 186–187, 196–199
 inequalities, 245, 270
 number, 206, 229, 704, 953, 955
 Rational Root Theorem, 229–230, 233, 239, 257, 269
 roots, 233–235, 269, 366, 429, 783, 948

rationalize the denominator, 474, 582, 594

reaction distance, 191

real numbers, 8, 46, 86, 206, 362, 421, 448, 493, 556, 592, 665, 697–698, 705, 738

real estate, 759, 762

reciprocal, 31, 72, 286, 372, 404, 413, 788

identities, 286, 421–423, 426, 441, 452, 477–478

ratios, 287

recreation, 61, 251, 304, 498, 793

rectangles, 36, 94, 220, 257, 271, 483, 549

area, 179, 341, 621, 961–962

perimeter, 188, 358, 366, 598, 828, 968

inscribed in circles, 628

rectangular

coordinate system, 352, 394, 559, 568–572, 579, 588, 591, 611, 646, 725, 737

converting to polar coordinates, 568–573

equations, 690

rectangular form of polar

coordinates, 570–572, 576, 579, 581, 586–587, 590, 594–597, 600, 604–607, 609–610, 689, 711, 748, 858, 880, 960, 975

hyperbolas, 648, 687

prisms, 482, 535, 537

representation, 663

recursive formula for arithmetic sequences, 760, 829

reduced row-echelon form, 106

reduced sample space, 861

reduction identities, 446–447

reference angles, 280–282, 291, 332, 335–336, 344–345, 412

reflection matrices, 88, 92–94, 119, 121, 137–139, 142, 145, 235, 447, 538, 540, 572, 618
 over the x -axis, 90, 139, 151
 over the y -axis, 90, 139, 196

refracted light, 461

regression equation, 377, 739, 742, 744–745

for linearized data, 747

regression line, 40, 42, 51, 60, 403

regular polygon, 300–303, 316–317, 429, 579, 603, 606, 661

related functions, 151, 283

relations, 5–7, 9–11, 19, 25, 31, 37, 51, 57, 61, 72, 111, 179, 377, 405, 436, 560, 684, 717

relative extreme, 172

maxima, 172–174, 176–177, 179, 199, 201

minima, 172–174, 176–177, 199, 201, 225

Remainder Theorem, 222, 224–226, 231, 235, 250, 268, 283, 366, 641, 880

repeating and terminal decimals, 106, 206

research, 800, 812, 820, 917

resultant, 486, 490, 493, 543, , 517

resultant force, 489, 492, 504, 513–516, 518, 583

resultant velocity, 487, 547, 677

retail, 18, 31, 50, 51, 104

rocketry, 951, 954

rhombus, 412, 621

Richter scale, 730

right angles, 429, 482

right triangles, 242, 285, 290–291, 307–308, 336, 340, 442, 489, 615, 618, 624, 632



- solving, 307, 309–311, 316, 328, 330–331, 338, 350, 376, 429, 511, 525, 533, 567, 641, 725, 765, 845
- trigonometric functions, 293, 295–298, 300–301, 304, 318, 337, 382, 425, 428, 431, 434–436, 513, 545, 702
- Roberval, Gillies**, 969
- roots**, 54, 206, 208–209, 213–214, 218, 228–230, 235, 268, 283, 445
- complex, 207, 210–211, 221, 230, 235, 250, 267–268
- Complex Conjugates Theorem, 216
- Integral Root Theorem, 230, 233, 267
- of complex numbers, 600, 603
- of equations, 206
- of polynomial equations, 207
- of quadratic equations, 213, 215
- rational, 233–235, 269, 366, 429, 948
- Rational Root Theorem, 229–230, 233, 239, 257, 269
- real, 212, 216
- zeros of polynomial functions, 206, 209, 248, 261, 267
- rose**, 563, 565, 607–608
- rotation**, 88, 92, 119, 121, 277, 279, 671, 684
- counterclockwise about the origin, 765
- matrices, 91, 461, 671
- of conics, 670–677
- row-echelon form**, 106
- row matrices**, 78–79, 81, 85, 119
- 925, 932, 938–939, 948, 960, 969, 976, 982–983
- scalar**, 80, 488, 492, 510, 543
- scalar multiplication**, 84, 93, 104, 119–120, 151, 158, 188, 494
- scalar product of matrices**, 80, 496
- scalar quantity**, 488
- scale factor**, 92–94, 121, 717
- scale model**, 234
- scatter plots**, 38, 41, 51, 60, 145, 151, 258–263, 270, 351, 592, 741, 744–745, 747
- scientific notation**, 64, 273, 282, 695, 700, 727, 749
- sculpting**, 227
- search and rescue**, 615–616
- secant**, 167, 188, 286, 292, 295, 301, 311, 336–337, 364, 395–403, 416, 418, 421–481
- secant line**, 951–952, 977
- secant-tangent angles**, 283
- second degree equations**, 678, 682
- seconds**, 277–278, 280–282, 290, 304, 336
- sectors**, 346, 349, 444
- security**, 305, 307, 395, 399, 401, 857
- segment addition**, 632
- segments of circles**, 350
- seismology**, 542, 623–624, 678, 684, 730
- Seki**, 97
- select models**, 389
- semi-interquartile range**, 909, 914–916, 935
- semi-major axes**, 631–641, 652, 947
- semi-minor axes**, 631–641, 688
- semi-perimeter**, 330
- semi-quartile range**, 925
- sequence**,
- arithmetic, 757–762, 765, 781, 791, 828, 830
- Fibonacci, 784, 806, 813
- geometric, 766–769, 771–773, 783, 793, 800, 830, 960
- infinite, 774, 777–778, 829
- iteration, 16–18, 584, 586–587, 589, 599, 604, 607
- limits of, 780
- n th terms, 760
- of odd natural numbers, 765
- of partial sums, 792
- series**,
- arithmetic, 759, 791, 829–830, 858
- comparison test, 787, 789, 797
- convergent, 786–793, 797, 805, 821, 829, 831, 907
- divergent, 786–793, 797, 805, 821, 831, 907
- exponential, 806, 812
- geometric, 769, 778, 830
- infinite, 778, 786, 791
- sigma notation, 794, 796–799, 814, 829, 831, 877, 911, 962
- trigonometric, 808–809, 811–812
- sextant**, 277
- shear**, 95
- sigma notation**, 794, 796–799, 814, 829, 831, 877, 911, 962
- similar figures**, 92, 284–285, 483
- simple interest**, 816
- simulations**, 877
- sine**, 285–289, 291, 294–295, 298–299, 301, 303, 311, 336–337, 359, 361, 364, 368, 370, 377, 389, 385, 389, 391, 406, 412, 415, 418, 421–481, 498, 515, 519
- sinusoidal functions**, 389–390, 393, 402, 412–413, 416
- slant asymptotes**, 183–184, 186–187, 197, 200, 560, 765
- slides**, 88
- slope**, 20–24, 27–30, 32, 33, 37, 39, 41, 44, 51, 56, 67, 72, 96, 104, 158, 167, 212, 221, 242, 288, 312, 332, 334, 462–463, 468, 474, 483, 506, 523, 617, 651, 693, 949, 951, 977
- negative, 22, 40, 60, 685
- of curves, 367, 949–950
- of perpendicular lines, 34, 145, 273
- of polynomial curves, 950
- positive, 22, 24, 26, 38, 40, 685
- of secants, 188
- of tangents, 957–958
- Slope Formula**, 272, 617, 950
- slope-intercept form of linear equations**, 21–22, 26–27, 29, 32, 37, 56–57, 59, 67, 86, 104, 109, 136, 158, 196, 290, 463, 471, 473, 522–523
- Snell's Law**, 284, 286, 289, 311, 461
- sociology**, 715, 733
- sound**, 404, 732, 746, 753
- space**, 196, 357, 975
- speed of light**, 943
- spherical geometry**, 435
- sphere**, 210, 319, 435
- spiral of Archimedes**, 564–565, 572, 607–608
- sports**, 9, 30, 51, 71, 75–76, 82, 123, 179, 201, 513, 519, 527, 529, 547, 629–630, 659, 670, 711, 864, 867, 879, 894, 916, 941, 959, 968
- baseball, 37, 213, 215, 264, 313–314, 316, 331, 533, 702, 844, 857, 895, 907
- basketball, 9, 310
- bicycling, 227, 356
- biking, 282, 350
- football, 291, 292, 889, 891, 903
- golf, 327, 328, 531
- hockey, 906
- river rafting, 498
- sailing, 559
- scuba diving, 11, 243
- skating, 742
- skiing, 222, 223



safety, 104, 716, 937

salaries, 711, 906

sales, 70, 96, 680, 731, 880, 893

sample, 930, 932

mean, 927–928, 936

sets of data, 927–932

space, 852, 855, 871, 877, 881

sampling errors, 928

SAT & ACT Preparation and

Practice, 12, 19, 25, 31, 37, 44, 51, 56, 62–65, 72, 77, 86, 95, 105, 111, 118, 124–125, 136, 145, 151, 158, 168, 179, 188, 196, 202–203, 212, 221, 228, 235, 242, 250, 257, 264, 272–273, 283, 290, 298, 304, 312, 319, 326, 332, 340–341, 351, 358, 367, 377, 386, 394, 403, 412, 418–419, 430, 436, 445, 455, 462, 469, 476, 482–483, 492, 499, 504, 511, 519, 525, 534, 542, 548–549, 560, 567, 573, 579, 585, 591, 598, 606, 612–613, 622, 630, 541, 652, 661, 669, 677, 684, 692–693, 703, 711, 717, 725, 732, 737, 748, 754–755, 765, 773, 783, 793, 800, 805, 814, 821, 828, 834–835, 845, 851, 858, 867, 874, 880, 886–887, 896, 907, 917,



- soccer, 332
 softball, 331, 530
 surfing, 498
 track and field, 463–464, 476
- square matrices**, 78, 99
- square root functions**, 137, 170
- standard deviation**
 of data, 908, 911–912, 914–917, 919, 921–926, 928, 931–933, 935–936, 975
 of frequency distributions, 889–892, 901, 904–906, 913, 931
 of frequency distributions, 913–914, 927
- standard error of the mean**, 927–928, 930–933, 936
- standard form of equations**
 linear, 21, 30–35, 44, 56, 463, 465, 468, 471, 473, 523, 575, 663
 circles, 624–625, 627
 ellipses, 633–634
 hyperbolas, 643, 647
 parabolas, 660
- standard normal curve**, 926
- standard position**, 277–278, 281, 291–292, 294–297, 304, 318, 336, 343, 351, 463, 465, 485, 493, 543, 553, 555–556, 588
- standard viewing window**, 259, 628
- statistical graphs**
 back-to-back bar graphs, 889
 bar graphs, 889, 924, 934, 937
 circle graphs, 857, 938
 frequency polygons, 892, 895, 918
 histograms, 890, 892, 933–934, 938
 scatter plots, 38, 41, 51, 60, 145, 151, 258–263, 270, 351, 592, 741, 744–745, 747
 stem-and-leaf plots, 899–900, 903–904, 917, 938
- statistics**, 249, 475, 669, 772, 764, 889–937
 measures of central tendency, 897–908, 933
 measures of variability, 908–917
 prediction equations, 38–39, 475
- stem-and-leaf plot**, 899–900, 903–904, 917, 938
- step functions**, 45–46, 50, 60, 104, 143, 156, 162, 166, 168, 198, 795
- stopping distance**, 191
- Suanshu**, 97
- Substitution Property of Equality**, 192
- subtend**
 arcs, 455
 central angles, 469
- subtraction**,
 complex numbers in rectangular form, 580–585, 609
 of functions, 14, 17–18, 25, 58
 of matrices, 80, 120
 of polynomials, 203
- success**, 852, 881, 883
- successive terms**, 801
- sum and difference rules**, 953, 955, 971
- sum identities**, 438–439, 441, 448–449, 477, 498, 591
- sum**
 of finite geometric series, 769, 774, 778
 of functions, 13
 of geometric series, 769, 774, 778
 of infinite series, 778–779, 781
 of matrices, 79, 82, 311
 of n th terms of geometric series, 766
 of series, 779
 of two partial fractions, 244
 of unit vectors, 495–498, 502–504, 591, 803
- surface area**
 of bubbles, 717
 of cubes, 318,
 of prisms, 187
- surveying**, 301, 351, 455, 481, 553, 557, 572, 579, 585, 611, 748, 960
- surveys**, 300, 896
- symbols** *see inside back cover*
- Sylvester, James Joseph**, 97
- symmetry**, 127, 135, 158, 198, 201, 351, 560, 630, 715, 803, 918, 926
 even functions, 133, 145, 163, 166, 197, 732
 identities, 421, 424–425, 439, 477–478
 line, 129, 134, 137, 158
 odd functions, 133, 135, 163, 166, 732
 point, 127
 with respect to lines, 250
 with respect to origins, 128, 133–134, 145, 640
 with respect to points, 212
 with respect to vertex, 687
 with respect to the x -axis, 134, 311
 with respect to the y -axis, 133, 311
 with respect to $y = x$, 311
 with respect to $y = -x$, 311
- synthetic division**, 223–227, 230–231, 235, 237–238, 240, 267, 269, 351, 573
- synthetic substitution**, 229
- systems of equations**, 67, 106, 123, 136, 158, 304, 429
 consistent, 67–68, 70–72, 86, 136, 196
 dependent, 67–68, 70–72, 86, 136, 196
 elimination method, 68, 70, 77, 106
 graphing, 112–114, 122, 682–684
 inconsistent, 67–68, 70–72, 86, 119, 136, 196
 independent, 67–68, 70–72, 86, 136, 196, 843, 883, 907
 solve, 67, 90, 96, 100, 103, 106, 120, 145, 221, 228, 257, 298, 318, 326, 386, 430, 455, 461, 476, 533, 564, 585, 690, 737
 substitution method, 67–68
 three variables, 73, 75
- systems of inequalities**, 102, 109–110, 118, 122, 179, 585, 686
 of second-degree inequalities, 686



- tangent lines**, 612, 951–952, 977
- tangents**, 171, 188, 285–289, 292, 295, 299, 301, 304, 311, 334, 336–337, 395–403, 406–412, 416, 418, 421–481, 490–492, 684
- technology**, 144, 282, 366, 783
also see graphing calculator
- telecommunications**, 61, 178, 201, 271
- temperature**, 56, 736
- terminal point**, 485, 487, 491
- terminal side**, 278–282, 291–297, 318, 337, 343–344, 351, 424, 437, 453, 553, 556, 608, 641
- testing**, 857, 873, 918, 920
- Theorems for Limits**, 776
- theoretical probabilities**, 877
- third-order determinants**, 99
- third-order matrix**, 82
- Thomson, James**, 534
- three-dimensional**
 bar graph, 890
 figures, 539, 546,
 space, 500, 535, 541, 544,
 vectors, 502, 508
- tides**, 378, 381, 392, 393, 402, 412
- tip-to-tail method**, 486, 516
- tourism**, 49, 60, 320, 323
- torque**, 195, 505, 507–509, 547
- trajectory**, 525, 527
- transcendental numbers**, 812
- transformations**, 88, 92–95, 121, 137, 140–142, 144–145, 149, 182, 185–187, 200, 228, 535, 537, 556, 597
 matrices, 535–536, 439–541
 of conics, 670–677
 of functions, 709
 of parent graphs, 748
 of three-dimensional figures, 541
- translations**, 3, 88, 92–94, 104–119, 137–138, 139–140, 142, 145, 540, 618
 matrices, 88, 95
 of circles, 624
 of conics, 670, 677
- transportation**, 30, 43, 51, 115, 122, 310, 317, 461, 467, 560, 629, 662, 668, 844, 859, 893, 948
- transversals**, 612
- transverse axes of hyperbolas**, 642–652
- trapezoid**, 92, 94, 764
- travel**, 78, 79, 519, 567, 711, 885
- tree diagrams**, 837, 839, 886

triangle inequalities, 549
triangle method, 486, 488, 491
triangles, 71, 93–94, 96, 250, 316, 331, 339, 483,
 in a plane, 319,
 inscribed in circles, 430,
 isosceles, 71, 302, 483, 516,
 619–621, 661
 Pascal's, 801–802, 804, 813
 right, 242, 285, 290–291, 307–308,
 336, 340, 442, 489, 615, 618, 624,
 632
 solving, 307, 309–311, 316, 328,
 330–331, 338, 350, 376, 429, 511,
 525, 533, 567, 641, 725, 765, 845

triangular numbers, 826

trigonometry, 302, 514, 534
 arccosine, 306, 335, 406–412, 416,
 703
 arcsine, 306, 335, 406–412, 416
 cosecant, 286, 292, 295, 298, 301,
 304, 311, 336–337, 364, 395–403,
 416, 418, 421–481, 492
 cosine, 285–289, 291, 294–295, 299,
 301, 304, 311, 336–337, 359, 364,
 368, 370–371, 376, 380, 389, 393,
 406–412, 415, 418, 421–481, 515,
 519, 630
 cotangent, 286, 289, 292, 295, 301,
 304, 311, 336, 421–481, 492
 equations, 285–289
 functions, 293–298, 301, 304, 318,
 337, 382, 425, 428, 431, 434–436,
 702
 graphs, 429, 469, 573
 graphs of inverses, 405–406, 409
 identities, 421–481, 504, 567, 594,
 664–665, 711
 inverse functions, 152, 154–156,
 221, 525, 585, 718
 Law of Cosines, 327–330, 335, 338,
 437, 510, 516, 557
 Law of Sines, 313–318, 321–322,
 324, 327–328, 335, 338, 516
 Snell's law, 284, 286, 289, 311, 461
 trigonometric form, 588
 trigonometric ratios, 285, 287–289,
 311, 335–336
 trigonometric series, 808–809,
 811–812

trinomials, 221



unbounded region, 113–117

undefined intervals, 710

undefined slope, 22

unit circles, 291–292, 294, 296,
 304–305, 335, 343, 345, 422–423,
 428, 454, 458, 461, 579, 819, 948

unit cost, 104

unit vectors, 495–496, 514, 543

unit of comparative loudness, 746

Upper Bound Theorem, 238–241, 351,
 498



variable, 68, 73, 112

variable cost, 77

variance, 912–914

vector, 485, 490, 497, 501, 510, 513,
 516, 534, 540, 543–544, 567, 573, 591
 addition of, 486
 components of, 402
 cross products, 545
 direction, 490, 520, 543
 dot product, 506
 equal, 498, 504, 543
 equations, 520–521, 525, 546
 operations, 494
 ordered pairs, 494
 ordered triple, 500–503, 511, 519
 parallel, 498, 523, 543, 547, 725
 parallelogram method, 486–487,
 491, 544
 parameter, 520–521, 543, 867
 perpendicular, 851
 resultant, 517
 three-dimensional space, 501–502,
 506–507
 tip-to-tail method, 486, 516
 triangle method, 486, 488, 491
 unit, 495–496, 514, 543

velocity, 157, 289
 components, 498

Venn diagrams, 861, 881

Verhulst population models, 815, 819

vertex, 413, 476,
 matrices, 88–95, 535, 537–539, 541
 of parallelograms, 487
 of polygonal boundaries, 108
 Theorem, 108

vertical

angles, 483, 612
 asymptotes, 180–187, 200, 492, 705,
 728
 axis, 716
 components, 488, 490–491, 669, 783
 displacement, 365, 528
 line, 7, 32, 35, 266, 685
 line test, 7–8, 25
 shift, 380–382, 393–394, 398,
 400–402, 412, 415–416, 925
 shift of sinusoidal functions, 391
 stretch, 183
 translations, 378, 380, 399
 vector, 489, 493
 velocity, 528, 531, 546

vertices, 88–89, 92–94, 96, 104, 109,
 168, 179, 188, 196, 277, 283, 311, 319,
 606, 620, 640, 880, 948
 of cones, 623
 of ellipses, 765
 of hyperbolas, 642–652, 783
 of parabolas, 653–661, 667

of parallelograms, 688
 of quadrilaterals, 377
 of rectangles, 621
 of squares, 77, 104, 652

veterinary medicine (pets), 116, 350

viewing window, 26, 87, 172, 230, 378,
 602

volume, 178, 186, 192, 194, 492, 548,
 612
 of cones, 192–193, 233, 235
 of cubes, 168
 of cylinders, 226
 of parallelepiped, 510
 of rectangular prisms, 178
 of rectangular solids, 168
 of spheres, 701, 975

Von Leibniz, Gottfried, 367



waste management, 258, 260

wavelength, 460

waves, 392

web page design, 559, 621

whiskers, 909

whole numbers, 206

window settings, 170, 334, 404

work, 124

Wright, Margaret H., 97



x-axis, 20, 22, 89, 91, 121, 129,
 134–135, 138, 144–145, 151, 198,
 201, 207–208, 218, 235–236, 250,
 298, 351, 361, 377, 463, 466, 476, 500,
 511, 517, 532, 560, 618, 630, 641, 671

x-coordinates, 21, 87–88, 265, 272,
 291, 293, 464, 615, 618, 771, 941

x-intercepts, 20, 22–23, 30, 61, 134,
 144, 187, 207–209, 211, 217, 220,
 469, 360–362, 365–366, 375,
 396–397, 728

x-value, 11, 37

xy-plane, 538

xz-plane, 538



y-axis, 20, 30, 89, 92–94, 129, 134–135,
 145, 151, 198, 201, 250, 291, 311, 351,
 366, 474, 481, 500, 560, 630, 636, 641,
 671, 728

- y-coordinates**, 21, 87–88, 172,
265–266, 291, 293, 411, 458, 464, 615,
618, 711, 941
- y-intercepts**, 20–23, 26–30, 32–33, 36,
44, 57, 145, 242, 312, 360, 362, 375,
396–397, 469, 523, 705–706
- yz-plane**, 538, 541



- z-axis**, 500, 508
- Zeno of Elea**, 969
- Zeno's paradox**, 790
- zero**
- coefficients, 238
 - denominators, 244
 - exponents, 695
 - matrix, 80
 - point, 500
 - power, 124
 - slope, 22
 - vector, 485, 496, 508
- zeros of a function**, 206, 209, 248, 261,
267
- approximating, 232
 - complex, 241
 - Descartes' Rule of Signs, 231–232,
234, 236–237
 - functions, 22–25, 57, 86, 206, 232,
271, 378, 498
 - linear functions, 20
 - polynomial functions, 240
 - positive real, 231, 233, 236, 241–242,
269, 290, 366, 560