

Sage for Undergraduates
authored by Gregory Bard
indexed by Tahnee Cooper

Term Page Number(s)

absolute value 10, 255
acceleration function 79-80
addition 1
air resistance 84
amicable pairs of numbers 152, 153
anchor 314
arbitrary lists 222
array, looping 274, 275
arrays 270-279
artery blockage 69-72
artery length 70
artery radius 70
aspect ratio 112
assertions 281
assume 60
asymptotes 13, 14
averaging numbers 276-277
B! 86-91
balancing reactions 74-79
binary 165
binomial 155, 156
biology 69-72
boolean variables 194
braces 2
brackets 2
break 265
capitalization 4, 5
Cardano's cubic formula 43
case/switch 281
chemistry 73-79, 161-163
coinage 228-230
combinations 155-157

- commands 4, 302
 - commas 2, 3, 303
 - comments 244
- common ratio 186
- comparators 257
 - compiler 282
- complex numbers 7, 43, 124, 125
 - complex roots 126
- composition of functions 33
 - constraints 191-193
- continued fractions 188, 189
 - contour plot 106-114, 120-122
 - control flow 249-262
 - convergents 188, 189
- converting degrees and radians 8
 - convex functions 180, 181
 - coordinate 15, 16
 - cos 7
 - cot 8
 - Coulomb's law 120
 - counter-battery fire 83
 - cross product 146
 - cryptology 85-91
 - csc 8
 - cube roots 124-127
 - curl 212-216
- cutting-and-pasting into template 293
 - debug 281, 282
 - decimal 3, 4, 32
 - define function 30, 31, 196
 - degenerate system 317
 - degrees of freedom 317
 - demand curve 94
 - derivatives 49-51
 - derivatives, partial 136, 137, 182, 207, 208
 - derivatives, plot 50
 - determinants 145, 146, 169, 170, 208
 - determines variable 314
- differential equations 195-203
- display source code 47

- divergence 210-212
 - division 1
 - divisors 36, 151-154
 - docstring 229
 - domain 128
- dot product 146
- dummy variable notation 324, 325
- early termination 255-257
 - eigenvalue 169-172, 180
 - eigenvectors 169-172
 - else 260-263
- error message 300, 301
- Euler's Phi function 149-151
 - evaluate 2, 4
 - exceptions 258-260
- expanded form 35
- exponential 4, 5
- exponents 1
 - factor 35, 36
 - factorial 155, 156, 167, 263, 264
- feasible points 190
- Fermat's Little Theorem 87-90
 - for loop 220-228
- free variable 314
- generate tables 220, 221
- geometric series 186, 187
- global variable 232
 - gradients 117-118, 120-122, 137, 183
- graph 2D 9-18
- graph hyperactive functions 99-100
- graph, implicit function 104-106
- graph, restrict x-values 128
- greatest common denominator 147, 148
- greatest common divisor 35
 - gridlines 15, 16
 - guess 263
- half-evaluation 130
- help 47-49, 304
- hexadecimal 165
- higher-order roots 4

- huge numbers 167, 168
- hyperbolic trig functions 157
 - if 249-251, 257
 - if-then-else 260-263
 - if-then-else, nested 281
 - indentation 221, 303
- industrial optimization 72-73
- inequalities, systems of 189-195
 - infeasible points 190
- infinite sums and series 184-188
- infinitely many solutions 29, 30
 - initial-value 198, 199
- insert into web template 292-294
 - installing sage 327-329
- integer linear programs 194
 - integral 51-60, 97-98
 - integral, definite 52
- integral, error function 59
 - integral, impossible 53, 54
 - integral, improper 57, 58
 - integral, indefinite 51, 52
 - integral, multiple 216, 217
- integration, by partial fractions 56, 57
 - interact, integral 297, 298
- interact, tangent line 287-294
 - interacts, building 286-298
- interest, compound 1, 6, 46, 131-134, 221
 - interest, simple 1
- internet connection 300, 301
- inverse trig functions 8
 - iteration 242, 243
- lagrange multipliers 181-184
- laplace transforms 203-205
 - laplacian 208, 209, 211, 212
 - latex 97, 168, 169, 205
- least common multiple 148, 149
 - least squares 173-175
 - lemniscate 103, 104
 - limits 158, 159, 224-226
- line breaks 302

- linear programming 189-195
 - linear systems 20, 21, 25-26, 39, 40, 173-175, 313-326
 - list notation 37, 38
 - list operations 272-274
 - lists 270-279
 - lists of points 270, 271
 - local variable 231
 - log-log plot 122-124
 - logarithms 5, 6, 42
 - logical operators 280
 - loop accumulators 223
 - loops 220-228, 233-248
 - matrices 19-29, 137-146, 169-175
 - matrix coordinates 23
 - matrix exponentiation 138
 - matrix factorizations 172, 173
 - matrix inverses 141, 142
 - matrix multiplication 138
 - matrix, hessian 180, 207-209
 - matrix, jacobian 209-211
 - matrix, kernel of a 143-145
 - matrix, permutation 321
 - matrix, reduced row echelon form 19, 20, 22-29, 139-142, 321
 - matrix, rook 321
 - matrix, vandermonde 26, 27
 - max 155
 - max and min 180, 208
 - maximizations 190, 191
 - maximizing profit 64-68
 - maximizing revenue 64-68
 - microeconomics 64-69, 112-114
 - min 155
 - minimizations 179-184, 191
 - minimize costs 64-68
 - modular arithmetic 154
 - mortgage 131-134
 - multiplication 1, 3
 - multiplication, implicit 299, 300
 - multivariable formulas 38, 39, 129, 130
 - multivariate functions 34, 129

- Newton's formula for gravity 134-136, 177-179
 - Newton's method 235-248, 251-257
 - Newton's method, for loop 238, 239
 - Newton's method, tabular 237
- Newton's method, while loop 264, 265
 - non-linear systems 40-42
 - nullity 143, 144, 317
 - number theory 147-155
 - numerical approximation 4, 241
 - octal 165
- odd roots of negative numbers 126-128
- optimization, constrained 181
- optimization, unconstrained 179-181
 - outputs, display 37, 40, 41
 - parabola 9
- parallel tangent lines 246-248
 - parameters 201-203, 242, 243
 - parentheses 2, 3, 302
 - permutations 155-157
- personal finance 131-134
 - physics 79-85, 118-121, 134-136, 177-179
 - pi 4
 - pivot 314, 321
 - plot 9, 10, 11
 - plot, add arrows 96-97
 - plot, add text 96-97
 - plot, color 190
 - plot, dashed line 98-99
 - plot, dotted line 98-99
 - plot, function 31,32
 - plot, grids 95-96
 - plot, integral 97-98
 - plot, label axes 93-94
- plot, multiple graphs 15, 16, 17, 18, 50
- plot, parametric 2D 114-116
 - plot, polar 100-104
- point of agreement 246
- Poiseuille's Law 69-72
- polyhedron 194
- polynomials 34-37

- present value of an annuity 2
- price-demand curve 26,27
- prime numbers 148-151, 264
- quartic equation 168, 169
- quick search 48
- quotes 14
- range 10
- reciprocal trig functions 8
- recursion 281
- regression 163-165
- reimann 184, 185
- remove 273
- repeated roots 265-267
- resources 309-311
- resources, programming 279, 280
- return 255
- return only certain roots 278, 279
- roots 36, 42, 44, 45
- rounding 155
- SageMathCloud 305-307
- saturation point 65
- save graph 10
- scatter plots 159-163
- scope 281
- sec 8
- selectors 296, 297
- share your results 60-62
- share your results, QR code reader 61
- share your results, save as 61
- share your results, save as PDF 62
- shipping costs 72
- shuffle 273
- simulations 282
- sin 7, 11
- single-variable formulas 37, 38
- sliders 291-293
- slope field 199-201
- smooth numbers 86, 87
- source code 47
- speed of sage 166, 167

- square root 3, 6, 7
 - strings 281
- subroutines 228-235, 288-292
- subtraction 1
 - sudoku 165, 166
 - sum 224
- summation identities 185
- summation proof 187
 - syntax 299
- tab completion 4
 - tan 8
- Taylor polynomials 175-179, 226, 227
- thermodynamics 109-112
 - timed out 301
- torpedo problem 201-203
 - trial division 267-269
- trigonometry 7, 8
- trigonometry, hyperbolic 157
- variable data types 280
 - variable, define 38, 39, 300
 - variables 32, 33
 - vector 146, 147
- vector calculus 206-217
 - vector length 146
 - vector notation 206, 207
 - vector plots 91, 116-122, 201, 214, 216
- velocity function 79, 81, 82, 203
- verbosity control 249-251
- viewing window 12, 13
 - viscosity 70
- volume flow rate 70
 - wasteful loops 223
 - while loop 263-270