

# Small angle approximations . percent error

angle (deg)	% error sin	% error cos	% error tan
0	0.000 %	0.000 %	0.000 %
1	0.005	-0.0000005	-0.010
2	0.020	-0.0000063	-0.041
3	0.046	-0.0000314	-0.091
4	0.081	-0.0000994	-0.162
5	0.127	-0.0002	-0.254
10	0.509	-0.004	-1.017
15	1.152	-0.020	-2.295
20	2.060	-0.066	-4.095
25	3.245	-0.166	-6.428
30	4.719	-0.358	-9.310
40	8.610	-1.271	-16.800
50	13.918	-3.665	-26.774
60	20.920	-9.662	-39.540
70	30.014	-25.827	-55.532
80	41.780	-85.474	-75.380
90	57.080	-∞	-∞

% error in  $f(x)$  defined as  $\% \text{ error} = \frac{f_{\text{approx}} - f}{f} \times 100$

$$\sin \theta \approx \theta$$

$$\cos \theta \approx 1 - \frac{\theta^2}{2}$$

$$\tan \theta \approx \theta$$

# Small number approximations

$x$	error in $(1+x)^{-1}$	error in $(1+x)^{1/2}$	error in $(1+x)^{-1/2}$	error in $\log(1+x)$
	∞ %	∞ %	∞ %	∞ %
-1.00				
-0.90	-81.000	73.925	-54.147	-60.913
-0.80	-64.000	34.164	-37.390	-50.293
-0.70	-49.000	18.673	-26.057	-41.859
-0.60	-36.000	10.860	-17.781	-34.519
-0.50	-25.000	6.006	-11.612	-27.865
-0.40	-16.000	3.280	-7.046	-21.695
-0.30	-9.000	1.574	-3.784	-15.890
-0.20	-4.000	0.623	-1.613	-10.372
-0.10	-1.000	0.139	-0.388	-5.008
-0.08	-0.640	0.087	-0.247	-4.056
-0.05	-0.360	0.048	-0.138	-3.031
-0.04	-0.160	0.021	-0.061	-2.004
-0.02	-0.040	0.005	-0.015	-1.003
-0.00	0.000	0.000	0.000	0.000
0.02	-0.040	0.005	-0.015	1.000
0.04	-0.160	0.019	-0.059	1.987
0.06	-0.360	0.042	-0.132	2.971
0.08	-0.640	0.074	-0.234	3.949
0.10	-1.000	0.114	-0.363	4.921
0.20	-4.000	0.416	-1.410	9.696
0.30	-9.000	0.862	-3.085	14.345
0.40	-16.000	1.419	-5.543	17.881
0.50	-25.000	2.062	-8.144	23.315
0.60	-36.000	2.774	-11.456	27.657
0.70	-49.000	3.540	-15.250	31.917
0.80	-64.000	4.350	-19.502	36.104
0.90	-81.000	5.194	-24.188	40.219
1.00	-100.000	6.066	-29.389	44.270

$$(1+x)^{-1} \approx 1-x$$

$$(1+x)^{1/2} \approx 1 + \frac{1}{2}x$$

$$(1+x)^{-1/2} \approx 1 - \frac{1}{2}x$$

$$\log(1+x) \approx x$$

$$\text{error } f \equiv \frac{f_{\text{approx}} - f}{f} \times 100$$