



Laser Toe / Tracking Gauge for Automotive Applications

Instruction Manual

Congratulations on your purchase of the **Laser Toe Gauge**. You have selected the most advanced, state of the art, portable laser alignment system and it's our wishes that you are completely satisfied. We can start by referring to the illustration or the system itself and giving a description of the major components. The extruded aluminum section has a hinged section to perform a dual function of support for the system and the ability to be adjustable for uneven ground surface. The hinged extension can be placed in any position in order to provide a firm three point support for the system. On the end of these extensions are adjustable ratchet leveling pads. In the case of the laser rail, the pad will be used to set the laser beam level to the ground surface. As for the mirror rail, the pad will be used for aiming the laser reflection to the target. On the main rails are self aligning feet that are set at the factory and are not typically adjusted.

Mounted on the side of the rails are the uprights used for positioning the wheel locating pins. The two up rights that are the farthest away from the mirror and laser are always to be set to the zero reference labels.. The other uprights are adjustable and are used to set the locating pins horizontally to your wheel radius. A label is provided for a reference in one half inch increments. On the uprights are the adjustable locating pins used for aligning the wheel locating pins vertically to your tire radius.

On the end of the mirror rail is your mirror mount and mirror. The mirror is 9 inches long to accommodate toe angles up to 3 degrees in toe-in and toe-out. This block is set at the factory and typically not adjustable.

Lastly we come to the laser head section. This section holds the laser, dial indicator for indicating your laser angle and vial level for coarse leveling.

The battery is installed as shown in Figure (A) below. The positive(+) end of the battery should face the switch end cap.

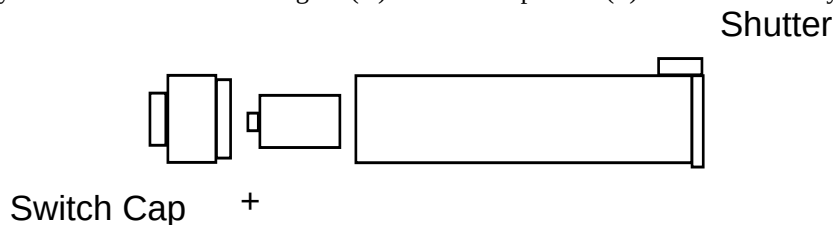


FIGURE A.

Note: The battery used here is a Duracell DL123A or Radio Shack 23-155. Both are 3 volt camera batteries. It is recommended that you use this lithium battery for the longest life. If you follow our instructions and use the laser at the point where the measurement is taken and power it off at all other times, you'll get plenty of usage from one battery.

CAUTION: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

A shutter for blocking the laser beam is provided also at the output and actuated to the off position simply by sliding it to one side. Also supplied on the shutter is a hairline scribe to aid in aligning the laser beam center to the calibrated center. Next we have the plunger dial indicator that is used to measure the angle of the laser. Finally, on the rail side of the laser head is the adjuster for setting the laser angle.

Since that completes the description of the system, we'll move on to the calibration.



CALIBRATION

The purpose for calibration is to set the laser beam perpendicular to the parallel planes set by the wheel locating pins. This calibration should be performed with any movement of the uprights or suspected change in any of the gauge components. The following procedure is best performed on a flat and level surface

1. Set the adjustable upright #1 to the zero reference label on both aluminum rails.
2. Place the **laser rail** against your wheel. Adjust upright #2 horizontally to the diameter of your wheel and adjust both wheel locating pins vertically close to the centerline of your wheel.
3. With the end upright #1 of the **mirror rail** at the zero reference, position both rails together. Align upright #2 and both wheel locating pins with the locating pins of the **laser rail** uprights.
4. Move both rails together until the pins **contact** each other without any space between.. A little tapping of the rail or pins will give you this firm contact condition. It is necessary that these pins are contacting each other. Anything other than this will result in a poor and inaccurate calibration.

Since we are now at a point where the laser will be installed and powered on, I would like to talk a little bit about laser safety. The laser we are using is a low power laser with a light output of only a few milliwatts. It is not to be confused with the powerful lasers intended for burning, cutting and drilling. Even though the power is low, the beam is to be treated with caution and common sense. The greatest potential for harm with this laser is to the eyes. Just as no one should stare at the sun or high intensity lamps, no one should look directly into the laser beam or stare at the reflections from the laser mirror used in this system. As an added precaution it would be wise to make the people in the area aware of the procedure you are performing. Lastly, **KEEP OUT OF REACH OF CHILDREN!**

5. Turn the On/Off button in, on the switch cap. At which time the laser will turn on. You should see a red glow. By alternating between the mirror rail leveling pad and the laser angle adjusting knob, adjust the laser beam reflection until the center of the laser beam aligns with the hairline scribe on the laser shutter. The leveling pad on the mirror rail will move the laser beam up and down, and the angle adjuster will move the laser beam side to side.
CAUTION: When adjusting the leveling pad, observe that the wheel locating pins are **still** contacting. Alternate between steps 5 and 6 until the laser beam aligns with the hairline scribe.

6. With the laser beam on the scribeline and the wheel locating pins still contacting each other, loosen the dial indicator face clamp. Turn the dial face until the zero on the dial lines up with the indicator hand, and secure the dial face with the dial face clamp.

We now have a situation where the four wheel locating pins, when placed perfectly apart from each other, and laser reflection on the scribeline the dial indicator will read zero on the dial indicator. Anything other than that will result in an angle between these points that directly correlates to the dial indicator. A dial indicator reading is based on a movement of .001" which equals 1 minute angle. Therefore an example reading of .060" on the dial equals 1 degree of toe/tracking between both wheels. **IMPORTANT: This does not mean you have a toe/tracking reading of .060 inches. You must convert the angle reading using the charts for you actual dimensional toe/tracking reading.**



Toe Angle Gauging

With calibration complete we can now perform the simple task of measuring toe angle on your vehicle or race car. This unit can be used in finding the toe-in or toe-out angle on the front or rear suspension. By design, the laser unit should be capable of performing this measurement on all race cars with aerodynamic body works installed.

1. Place both rail systems near each wheel and align the wheel locating pins to your vehicle wheels. Swing the hinged sections to a point where a firm 3 point support is achieved.
2. Using the leveling pads, turn on the laser and adjust the laser beam so it's parallel to the ground and hitting the mirror. You can do this by observing the distance from the laser beam to the ground over a distance of several feet. Once the beam is parallel to the ground and hitting the mirror we normally do not adjust the leveling pad again since the following steps with the mirror rail will take care of the adjusting the laser reflection.
3. Move both rails into your vehicle wheels, so the wheel locating points contact the wheel. By tapping on the uprights you should be able to determine if there is a gap between your pin and wheel.
NOTE: Care should be taken here as any distance between the locating pins and your vehicle wheel will cause you to have inaccurate toe angle reading.

4. With the laser turned on and beam reflecting off the mirror, locate the laser reflection. Coarsely adjust the laser angle with the angle adjustment knob on the side of the laser head until the laser reflection is in line with the hairline scribe on the shutter. If the laser is shooting high or low to the shutter scribeline we will fix that in the next step.
5. Using the mirror rail leveling pad adjust the laser beam reflection up or down until the laser beam hits any part of the shutter. At this point you may find it necessary to alternate between steps 3, 4 and 5.
6. With the conditions of steps 3, 4 and 5 met, adjust the laser angle with the angle adjustment knob until the reflection of the laser beam is centered on the scribe line. By swinging the laser beam back and forth across this indicator you should be able to resolve to less than .0005" on the dial.

7. Read the dial indicator for your toe angle across both wheels. .001" = 1 minute, 60 minutes = 1 degree.
Conversion to fraction example: .008" or 8 divisions on the dial equals 8 minutes. Use the attached table to find your dimensional toe in or toe out for your vehicle. In this example look down the column reading of 8 minutes, move across this line until you reach the tire or wheel size you are using. For this example we will use a 13" diameter wheel or tire. Your toe-in or toe-out would be .0303". For metric conversion multiply by 25.4 .

Note: A.R.T recommends that use of the conversion chart to be used only in the initial usage of the gauge until the operator understands what toe angles are used for your specific race car or vehicle. By understanding the use of angles the conversion charts can be eliminated. This will remove the possible misunderstanding between different methods people use in calibrating toe angle with respect to tire diameter or wheel diameter.

Now that we have addressed the normal procedure for performing toe readings there is a situation where by the inaccurate toe readings may be encountered. This is due to wheel run out or bent rims. To help evaluate this problem and isolate any suspicions, the following simple procedure can be performed.

After taking your toe reading and before moving your gauge, mark your wheels at the location of each wheel locating pin. After doing so, rotate your wheels 180 degrees. Perform a normal toe reading again. If this toe reading is different than the previous, this indicates that a run out or bent rim exists. (We are assuming your suspension components are not worn out and have excessive play). By averaging these two readings the error is minimized, giving you a more accurate toe reading.

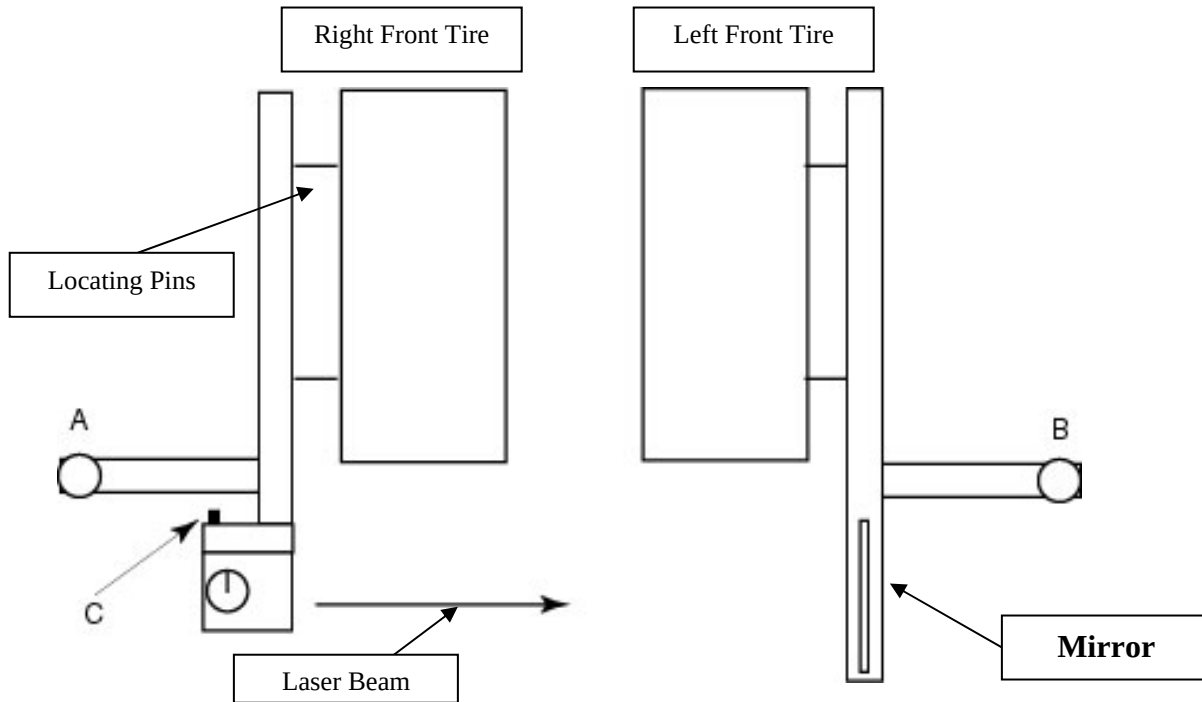
Thank You and Good Luck!
 Advanced Racing Technologies, Inc.

Federal Regulations: Complies with 21 CFR parts 1040.10 and 1040.11



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Laser Toe Gauge Illustration Quick Procedure



Top View Looking Down

1. Adjust uprights and locating pins to wheel size
2. Place laser and mirror section with pins against wheels
3. Adjust leveler "A" for laser beam to hit center of mirror
4. Adjust leveler "B" to move laser beam vertically to reflect back to the same height as laser output
5. Adjust laser adjustment "C" to move laser beam horizontally to laser output scribeline.
6. Repeat step 2 and 5 until pins are in contact with wheel and laser beam is aligned to scribeline
7. Read dial indicator for toe angle. Each division on the dial equals a one minute angle or 1/60 of a degree.
Example: .030" or 30 divisions on the dial equals 30/60 of a degree or .5 degrees of toe angle.

NOTE: For fast lube applications, once the initial procedure is done at the place that all alignment checking will be preformed, steps 2 and 5 will only be required to get a toe angle reading

What can be done for wheel run out?

To help evaluate this problem and isolate any suspicions, the following simple procedure can be performed. After taking your toe reading and before moving your gauge, mark your wheels at the location of each wheel locating pin. After doing so, rotate your wheels 180 degrees. Perform a normal toe reading again. If this toe reading is different than the previous, this indicates that a run out or bent rim exists. (We are assuming your suspension components are not worn out and have excessive play). By averaging these two readings and adjusting to this average this error is minimized, giving you a more accurate toe reading. For severe cases we suggest that the wheels be replaced before any adjustments be made.

I have a straight steering wheel. How do I make an adjustment without affecting it?

Simply adjust each tie rod the same amount until you achieve your toe setting. Try a ¼ of a turn on each tie rod to determine how much that will change your toe reading.

My steering wheel is turned but my toe settings are correct. What do I do?

The solution is simple but it could be time consuming. Simply tighten up on one tie rod and let out on the other. If the steering wheel gets worse then reverse the procedure until the steering wheel is straight. Use the ¼ turn method on each tie rod and you should maintain your toe setting. This will become easier and faster with experience. If you find this inconvenient and time consuming, think about how inconvenient and time consuming it would be to transport your vehicle to and from the alignment shop, and the money you would lose paying to get your steering wheel straight. The big alignment systems do make this easy but think about making those monthly payments you would be making on one of those systems and you'll discover that maybe this isn't to inconvenient after all.

I have a vehicle with independent rear suspension. Can I use the toe gauge on the rear?

Since the laser gives total toe reading you can use the laser to get your total toe, but it will not tell you if the wheels have equal thrust angle. The laser toe gauge is normally intended for front end alignment only.

Note: ART does carry additional equipment that can help you set individual toe angle. Call for explanation.

I have a special situation that may require special equipment. Can ART help?

Yes, unlike most companies, ART has custom design capabilities. Just tell us your problem and you will most likely get a solution.

Does ART offer phone support?

Yes and its free to all of our customers.

Thank You And Good Luck!
Advanced Racing Technologies, Inc.
17 North Cross Road
Staatsburg, New York 12580
Tel/Fax 845-889-4499
Email – info1@advancedracing.com
Internet Web site - www.advancedracing.com

Federal Regulations: Complies with 21 CFR parts 1040.10 and 1040.11

Minutes	Degrees	Tire or wheel Diameter									
		13	14	15	16	17	18	19	20	21	22
1	0.0167	0.0038	0.0041	0.0044	0.0047	0.0049	0.0052	0.0055	0.0058	0.0061	0.0064
2	0.0333	0.0076	0.0081	0.0087	0.0093	0.0099	0.0105	0.0111	0.0116	0.0122	0.0128
3	0.0500	0.0113	0.0122	0.0131	0.0140	0.0148	0.0157	0.0166	0.0175	0.0183	0.0192
4	0.0667	0.0151	0.0163	0.0175	0.0186	0.0198	0.0210	0.0221	0.0233	0.0244	0.0256
5	0.0833	0.0189	0.0204	0.0218	0.0233	0.0247	0.0262	0.0276	0.0291	0.0306	0.0320
6	0.1000	0.0227	0.0244	0.0262	0.0279	0.0297	0.0314	0.0332	0.0349	0.0367	0.0384
7	0.1167	0.0265	0.0285	0.0306	0.0326	0.0346	0.0367	0.0387	0.0407	0.0428	0.0448
8	0.1333	0.0303	0.0326	0.0349	0.0372	0.0396	0.0419	0.0442	0.0466	0.0489	0.0512
9	0.1500	0.0340	0.0367	0.0393	0.0419	0.0445	0.0471	0.0498	0.0524	0.0550	0.0576
10	0.1667	0.0378	0.0407	0.0436	0.0466	0.0495	0.0524	0.0553	0.0582	0.0611	0.0640
11	0.1833	0.0416	0.0448	0.0480	0.0512	0.0544	0.0576	0.0608	0.0640	0.0672	0.0704
12	0.2000	0.0454	0.0489	0.0524	0.0559	0.0594	0.0629	0.0663	0.0698	0.0733	0.0768
13	0.2167	0.0492	0.0530	0.0567	0.0605	0.0643	0.0681	0.0719	0.0757	0.0794	0.0832
14	0.2333	0.0530	0.0570	0.0611	0.0652	0.0693	0.0733	0.0774	0.0815	0.0856	0.0896
15	0.2500	0.0567	0.0611	0.0655	0.0698	0.0742	0.0786	0.0829	0.0873	0.0917	0.0960
16	0.2667	0.0605	0.0652	0.0698	0.0745	0.0792	0.0838	0.0885	0.0931	0.0978	0.1024
17	0.2833	0.0643	0.0693	0.0742	0.0792	0.0841	0.0890	0.0940	0.0989	0.1039	0.1088
18	0.3000	0.0681	0.0733	0.0786	0.0838	0.0890	0.0943	0.0995	0.1048	0.1100	0.1152
19	0.3167	0.0719	0.0774	0.0829	0.0885	0.0940	0.0995	0.1051	0.1106	0.1161	0.1216
20	0.3333	0.0757	0.0815	0.0873	0.0931	0.0989	0.1048	0.1106	0.1164	0.1222	0.1280
21	0.3500	0.0794	0.0856	0.0917	0.0978	0.1039	0.1100	0.1161	0.1222	0.1283	0.1344
22	0.3667	0.0832	0.0896	0.0960	0.1024	0.1088	0.1152	0.1216	0.1280	0.1344	0.1408
23	0.3833	0.0870	0.0937	0.1004	0.1071	0.1138	0.1205	0.1272	0.1339	0.1406	0.1472
24	0.4000	0.0908	0.0978	0.1048	0.1117	0.1187	0.1257	0.1327	0.1397	0.1467	0.1536
25	0.4167	0.0946	0.1018	0.1091	0.1164	0.1237	0.1309	0.1382	0.1455	0.1528	0.1600
26	0.4333	0.0984	0.1059	0.1135	0.1211	0.1286	0.1362	0.1438	0.1513	0.1589	0.1665
27	0.4500	0.1021	0.1100	0.1179	0.1257	0.1336	0.1414	0.1493	0.1571	0.1650	0.1729
28	0.4667	0.1059	0.1141	0.1222	0.1304	0.1385	0.1467	0.1548	0.1630	0.1711	0.1793
29	0.4833	0.1097	0.1181	0.1266	0.1350	0.1435	0.1519	0.1603	0.1688	0.1772	0.1857
30	0.5000	0.1135	0.1222	0.1309	0.1397	0.1484	0.1571	0.1659	0.1746	0.1833	0.1921
31	0.5167	0.1173	0.1263	0.1353	0.1443	0.1534	0.1624	0.1714	0.1804	0.1894	0.1985
32	0.5333	0.1211	0.1304	0.1397	0.1490	0.1583	0.1676	0.1769	0.1862	0.1955	0.2049
33	0.5500	0.1248	0.1344	0.1440	0.1536	0.1632	0.1729	0.1825	0.1921	0.2017	0.2113
34	0.5667	0.1286	0.1385	0.1484	0.1583	0.1682	0.1781	0.1880	0.1979	0.2078	0.2177
35	0.5833	0.1324	0.1426	0.1528	0.1630	0.1731	0.1833	0.1935	0.2037	0.2139	0.2241
36	0.6000	0.1362	0.1467	0.1571	0.1676	0.1781	0.1886	0.1990	0.2095	0.2200	0.2305
37	0.6167	0.1400	0.1507	0.1615	0.1723	0.1830	0.1938	0.2046	0.2153	0.2261	0.2369
38	0.6333	0.1438	0.1548	0.1659	0.1769	0.1880	0.1990	0.2101	0.2212	0.2322	0.2433
39	0.6500	0.1475	0.1589	0.1702	0.1816	0.1929	0.2043	0.2156	0.2270	0.2383	0.2497
40	0.6667	0.1513	0.1630	0.1746	0.1862	0.1979	0.2095	0.2212	0.2328	0.2444	0.2561
41	0.6833	0.1551	0.1670	0.1790	0.1909	0.2028	0.2148	0.2267	0.2386	0.2505	0.2625
42	0.7000	0.1589	0.1711	0.1833	0.1955	0.2078	0.2200	0.2322	0.2444	0.2567	0.2689
43	0.7167	0.1627	0.1752	0.1877	0.2002	0.2127	0.2252	0.2377	0.2503	0.2628	0.2753
44	0.7333	0.1664	0.1793	0.1921	0.2049	0.2177	0.2305	0.2433	0.2561	0.2689	0.2817
45	0.7500	0.1702	0.1833	0.1964	0.2095	0.2226	0.2357	0.2488	0.2619	0.2750	0.2881
46	0.7667	0.1740	0.1874	0.2008	0.2142	0.2276	0.2409	0.2543	0.2677	0.2811	0.2945
47	0.7833	0.1778	0.1915	0.2051	0.2188	0.2325	0.2462	0.2599	0.2735	0.2872	0.3009
48	0.8000	0.1816	0.1955	0.2095	0.2235	0.2374	0.2514	0.2654	0.2794	0.2933	0.3073
49	0.8167	0.1854	0.1996	0.2139	0.2281	0.2424	0.2567	0.2709	0.2852	0.2994	0.3137
50	0.8333	0.1891	0.2037	0.2182	0.2328	0.2473	0.2619	0.2764	0.2910	0.3055	0.3201

	Minutes	Degrees	Tire or wheel Diameter									
			13	14	15	16	17	18	19	20	21	22
51	0.8500		0.1929	0.2078	0.2226	0.2374	0.2523	0.2671	0.2820	0.2968	0.3116	0.3265
52	0.8667		0.1967	0.2118	0.2270	0.2421	0.2572	0.2724	0.2875	0.3026	0.3178	0.3329
53	0.8833		0.2005	0.2159	0.2313	0.2468	0.2622	0.2776	0.2930	0.3084	0.3239	0.3393
54	0.9000		0.2043	0.2200	0.2357	0.2514	0.2671	0.2828	0.2986	0.3143	0.3300	0.3457
55	0.9167		0.2081	0.2241	0.2401	0.2561	0.2721	0.2881	0.3041	0.3201	0.3361	0.3521
56	0.9333		0.2118	0.2281	0.2444	0.2607	0.2770	0.2933	0.3096	0.3259	0.3422	0.3585
57	0.9500		0.2156	0.2322	0.2488	0.2654	0.2820	0.2986	0.3151	0.3317	0.3483	0.3649
58	0.9667		0.2194	0.2363	0.2532	0.2700	0.2869	0.3038	0.3207	0.3375	0.3544	0.3713
59	0.9833		0.2232	0.2404	0.2575	0.2747	0.2919	0.3090	0.3262	0.3434	0.3605	0.3777
60	1.0000		0.2270	0.2444	0.2619	0.2793	0.2968	0.3143	0.3317	0.3492	0.3666	0.3841
61	1.0167		0.2308	0.2485	0.2663	0.2840	0.3018	0.3195	0.3373	0.3550	0.3728	0.3905
62	1.0333		0.2345	0.2526	0.2706	0.2887	0.3067	0.3247	0.3428	0.3608	0.3789	0.3969
63	1.0500		0.2383	0.2566	0.2750	0.2933	0.3116	0.3300	0.3483	0.3666	0.3850	0.4033
64	1.0667		0.2421	0.2607	0.2793	0.2980	0.3166	0.3352	0.3538	0.3725	0.3911	0.4097
65	1.0833		0.2459	0.2648	0.2837	0.3026	0.3215	0.3404	0.3594	0.3783	0.3972	0.4161
66	1.1000		0.2497	0.2689	0.2881	0.3073	0.3265	0.3457	0.3649	0.3841	0.4033	0.4225
67	1.1167		0.2534	0.2729	0.2924	0.3119	0.3314	0.3509	0.3704	0.3899	0.4094	0.4289
68	1.1333		0.2572	0.2770	0.2968	0.3166	0.3364	0.3562	0.3759	0.3957	0.4155	0.4353
69	1.1500		0.2610	0.2811	0.3012	0.3212	0.3413	0.3614	0.3815	0.4016	0.4216	0.4417
70	1.1667		0.2648	0.2852	0.3055	0.3259	0.3463	0.3666	0.3870	0.4074	0.4277	0.4481
71	1.1833		0.2686	0.2892	0.3099	0.3306	0.3512	0.3719	0.3925	0.4132	0.4339	0.4545
72	1.2000		0.2724	0.2933	0.3143	0.3352	0.3562	0.3771	0.3981	0.4190	0.4400	0.4609
73	1.2167		0.2761	0.2974	0.3186	0.3399	0.3611	0.3823	0.4036	0.4248	0.4461	0.4673
74	1.2333		0.2799	0.3015	0.3230	0.3445	0.3660	0.3876	0.4091	0.4306	0.4522	0.4737
75	1.2500		0.2837	0.3055	0.3273	0.3492	0.3710	0.3928	0.4146	0.4365	0.4583	0.4801
76	1.2667		0.2875	0.3096	0.3317	0.3538	0.3759	0.3981	0.4202	0.4423	0.4644	0.4865
77	1.2833		0.2913	0.3137	0.3361	0.3585	0.3809	0.4033	0.4257	0.4481	0.4705	0.4929
78	1.3000		0.2950	0.3177	0.3404	0.3631	0.3858	0.4085	0.4312	0.4539	0.4766	0.4993
79	1.3167		0.2988	0.3218	0.3448	0.3678	0.3908	0.4138	0.4368	0.4597	0.4827	0.5057
80	1.3333		0.3026	0.3259	0.3492	0.3724	0.3957	0.4190	0.4423	0.4656	0.4888	0.5121
81	1.3500		0.3064	0.3300	0.3535	0.3771	0.4007	0.4242	0.4478	0.4714	0.4949	0.5185
82	1.3667		0.3102	0.3340	0.3579	0.3818	0.4056	0.4295	0.4533	0.4772	0.5011	0.5249
83	1.3833		0.3140	0.3381	0.3623	0.3864	0.4106	0.4347	0.4589	0.4830	0.5072	0.5313
84	1.4000		0.3177	0.3422	0.3666	0.3911	0.4155	0.4399	0.4644	0.4888	0.5133	0.5377
85	1.4167		0.3215	0.3463	0.3710	0.3957	0.4205	0.4452	0.4699	0.4946	0.5194	0.5441
86	1.4333		0.3253	0.3503	0.3754	0.4004	0.4254	0.4504	0.4754	0.5005	0.5255	0.5505
87	1.4500		0.3291	0.3544	0.3797	0.4050	0.4303	0.4557	0.4810	0.5063	0.5316	0.5569
88	1.4667		0.3329	0.3585	0.3841	0.4097	0.4353	0.4609	0.4865	0.5121	0.5377	0.5633
89	1.4833		0.3366	0.3625	0.3884	0.4143	0.4402	0.4661	0.4920	0.5179	0.5438	0.5697
90	1.5000		0.3404	0.3666	0.3928	0.4190	0.4452	0.4714	0.4976	0.5237	0.5499	0.5761
91	1.5167		0.3442	0.3707	0.3972	0.4236	0.4501	0.4766	0.5031	0.5296	0.5560	0.5825
92	1.5333		0.3480	0.3748	0.4015	0.4283	0.4551	0.4818	0.5086	0.5354	0.5621	0.5889
93	1.5500		0.3518	0.3788	0.4059	0.4330	0.4600	0.4871	0.5141	0.5412	0.5683	0.5953
94	1.5667		0.3556	0.3829	0.4103	0.4376	0.4650	0.4923	0.5197	0.5470	0.5744	0.6017
95	1.5833		0.3593	0.3870	0.4146	0.4423	0.4699	0.4975	0.5252	0.5528	0.5805	0.6081
96	1.6000		0.3631	0.3911	0.4190	0.4469	0.4749	0.5028	0.5307	0.5586	0.5866	0.6145
97	1.6167		0.3669	0.3951	0.4233	0.4516	0.4798	0.5080	0.5362	0.5645	0.5927	0.6209
98	1.6333		0.3707	0.3992	0.4277	0.4562	0.4847	0.5133	0.5418	0.5703	0.5988	0.6273
99	1.6500		0.3745	0.4033	0.4321	0.4609	0.4897	0.5185	0.5473	0.5761	0.6049	0.6337
100	1.6667		0.3782	0.4073	0.4364	0.4655	0.4946	0.5237	0.5528	0.5819	0.6110	0.6401

Minutes		Degrees		Tire or wheel Diameter							
		23	24	25	26	27	28	29	30	31	32
1	0.0167	0.0067	0.0070	0.0073	0.0076	0.0079	0.0081	0.0084	0.0087	0.0090	0.0093
2	0.0333	0.0134	0.0140	0.0145	0.0151	0.0157	0.0163	0.0169	0.0175	0.0180	0.0186
3	0.0500	0.0201	0.0210	0.0218	0.0227	0.0236	0.0244	0.0253	0.0262	0.0271	0.0279
4	0.0667	0.0268	0.0279	0.0291	0.0303	0.0314	0.0326	0.0338	0.0349	0.0361	0.0372
5	0.0833	0.0335	0.0349	0.0364	0.0378	0.0393	0.0407	0.0422	0.0436	0.0451	0.0466
6	0.1000	0.0402	0.0419	0.0436	0.0454	0.0471	0.0489	0.0506	0.0524	0.0541	0.0559
7	0.1167	0.0469	0.0489	0.0509	0.0530	0.0550	0.0570	0.0591	0.0611	0.0631	0.0652
8	0.1333	0.0535	0.0559	0.0582	0.0605	0.0629	0.0652	0.0675	0.0698	0.0722	0.0745
9	0.1500	0.0602	0.0629	0.0655	0.0681	0.0707	0.0733	0.0760	0.0786	0.0812	0.0838
10	0.1667	0.0669	0.0698	0.0727	0.0757	0.0786	0.0815	0.0844	0.0873	0.0902	0.0931
11	0.1833	0.0736	0.0768	0.0800	0.0832	0.0864	0.0896	0.0928	0.0960	0.0992	0.1024
12	0.2000	0.0803	0.0838	0.0873	0.0908	0.0943	0.0978	0.1013	0.1048	0.1083	0.1117
13	0.2167	0.0870	0.0908	0.0946	0.0984	0.1021	0.1059	0.1097	0.1135	0.1173	0.1211
14	0.2333	0.0937	0.0978	0.1018	0.1059	0.1100	0.1141	0.1181	0.1222	0.1263	0.1304
15	0.2500	0.1004	0.1048	0.1091	0.1135	0.1179	0.1222	0.1266	0.1309	0.1353	0.1397
16	0.2667	0.1071	0.1117	0.1164	0.1211	0.1257	0.1304	0.1350	0.1397	0.1443	0.1490
17	0.2833	0.1138	0.1187	0.1237	0.1286	0.1336	0.1385	0.1435	0.1484	0.1534	0.1583
18	0.3000	0.1205	0.1257	0.1309	0.1362	0.1414	0.1467	0.1519	0.1571	0.1624	0.1676
19	0.3167	0.1272	0.1327	0.1382	0.1438	0.1493	0.1548	0.1603	0.1659	0.1714	0.1769
20	0.3333	0.1339	0.1397	0.1455	0.1513	0.1571	0.1630	0.1688	0.1746	0.1804	0.1862
21	0.3500	0.1406	0.1467	0.1528	0.1589	0.1650	0.1711	0.1772	0.1833	0.1894	0.1956
22	0.3667	0.1472	0.1536	0.1600	0.1665	0.1729	0.1793	0.1857	0.1921	0.1985	0.2049
23	0.3833	0.1539	0.1606	0.1673	0.1740	0.1807	0.1874	0.1941	0.2008	0.2075	0.2142
24	0.4000	0.1606	0.1676	0.1746	0.1816	0.1886	0.1956	0.2025	0.2095	0.2165	0.2235
25	0.4167	0.1673	0.1746	0.1819	0.1891	0.1964	0.2037	0.2110	0.2182	0.2255	0.2328
26	0.4333	0.1740	0.1816	0.1891	0.1967	0.2043	0.2118	0.2194	0.2270	0.2345	0.2421
27	0.4500	0.1807	0.1886	0.1964	0.2043	0.2121	0.2200	0.2279	0.2357	0.2436	0.2514
28	0.4667	0.1874	0.1955	0.2037	0.2118	0.2200	0.2281	0.2363	0.2444	0.2526	0.2607
29	0.4833	0.1941	0.2025	0.2110	0.2194	0.2279	0.2363	0.2447	0.2532	0.2616	0.2700
30	0.5000	0.2008	0.2095	0.2182	0.2270	0.2357	0.2444	0.2532	0.2619	0.2706	0.2794
31	0.5167	0.2075	0.2165	0.2255	0.2345	0.2436	0.2526	0.2616	0.2706	0.2796	0.2887
32	0.5333	0.2142	0.2235	0.2328	0.2421	0.2514	0.2607	0.2700	0.2794	0.2887	0.2980
33	0.5500	0.2209	0.2305	0.2401	0.2497	0.2593	0.2689	0.2785	0.2881	0.2977	0.3073
34	0.5667	0.2276	0.2375	0.2473	0.2572	0.2671	0.2770	0.2869	0.2968	0.3067	0.3166
35	0.5833	0.2343	0.2444	0.2546	0.2648	0.2750	0.2852	0.2954	0.3055	0.3157	0.3259
36	0.6000	0.2409	0.2514	0.2619	0.2724	0.2828	0.2933	0.3038	0.3143	0.3248	0.3352
37	0.6167	0.2476	0.2584	0.2692	0.2799	0.2907	0.3015	0.3122	0.3230	0.3338	0.3445
38	0.6333	0.2543	0.2654	0.2764	0.2875	0.2986	0.3096	0.3207	0.3317	0.3428	0.3538
39	0.6500	0.2610	0.2724	0.2837	0.2951	0.3064	0.3178	0.3291	0.3405	0.3518	0.3632
40	0.6667	0.2677	0.2794	0.2910	0.3026	0.3143	0.3259	0.3376	0.3492	0.3608	0.3725
41	0.6833	0.2744	0.2863	0.2983	0.3102	0.3221	0.3341	0.3460	0.3579	0.3699	0.3818
42	0.7000	0.2811	0.2933	0.3055	0.3178	0.3300	0.3422	0.3544	0.3667	0.3789	0.3911
43	0.7167	0.2878	0.3003	0.3128	0.3253	0.3378	0.3504	0.3629	0.3754	0.3879	0.4004
44	0.7333	0.2945	0.3073	0.3201	0.3329	0.3457	0.3585	0.3713	0.3841	0.3969	0.4097
45	0.7500	0.3012	0.3143	0.3274	0.3405	0.3536	0.3666	0.3797	0.3928	0.4059	0.4190
46	0.7667	0.3079	0.3213	0.3346	0.3480	0.3614	0.3748	0.3882	0.4016	0.4150	0.4283
47	0.7833	0.3146	0.3282	0.3419	0.3556	0.3693	0.3829	0.3966	0.4103	0.4240	0.4377
48	0.8000	0.3213	0.3352	0.3492	0.3632	0.3771	0.3911	0.4051	0.4190	0.4330	0.4470
49	0.8167	0.3279	0.3422	0.3565	0.3707	0.3850	0.3992	0.4135	0.4278	0.4420	0.4563
50	0.8333	0.3346	0.3492	0.3637	0.3783	0.3928	0.4074	0.4219	0.4365	0.4510	0.4656

Minutes Degrees		Tire or wheel Diameter									
		23	24	25	26	27	28	29	30	31	32
51	0.8500	0.3413	0.3562	0.3710	0.3859	0.4007	0.4155	0.4304	0.4452	0.4601	0.4749
52	0.8667	0.3480	0.3632	0.3783	0.3934	0.4085	0.4237	0.4388	0.4539	0.4691	0.4842
53	0.8833	0.3547	0.3701	0.3856	0.4010	0.4164	0.4318	0.4472	0.4627	0.4781	0.4935
54	0.9000	0.3614	0.3771	0.3928	0.4085	0.4243	0.4400	0.4557	0.4714	0.4871	0.5028
55	0.9167	0.3681	0.3841	0.4001	0.4161	0.4321	0.4481	0.4641	0.4801	0.4961	0.5121
56	0.9333	0.3748	0.3911	0.4074	0.4237	0.4400	0.4563	0.4726	0.4889	0.5052	0.5214
57	0.9500	0.3815	0.3981	0.4147	0.4312	0.4478	0.4644	0.4810	0.4976	0.5142	0.5308
58	0.9667	0.3882	0.4051	0.4219	0.4388	0.4557	0.4726	0.4894	0.5063	0.5232	0.5401
59	0.9833	0.3949	0.4120	0.4292	0.4464	0.4635	0.4807	0.4979	0.5150	0.5322	0.5494
60	1.0000	0.4016	0.4190	0.4365	0.4539	0.4714	0.4889	0.5063	0.5238	0.5412	0.5587
61	1.0167	0.4083	0.4260	0.4438	0.4615	0.4793	0.4970	0.5148	0.5325	0.5503	0.5680
62	1.0333	0.4149	0.4330	0.4510	0.4691	0.4871	0.5051	0.5232	0.5412	0.5593	0.5773
63	1.0500	0.4216	0.4400	0.4583	0.4766	0.4950	0.5133	0.5316	0.5500	0.5683	0.5866
64	1.0667	0.4283	0.4470	0.4656	0.4842	0.5028	0.5214	0.5401	0.5587	0.5773	0.5959
65	1.0833	0.4350	0.4539	0.4728	0.4918	0.5107	0.5296	0.5485	0.5674	0.5863	0.6052
66	1.1000	0.4417	0.4609	0.4801	0.4993	0.5185	0.5377	0.5569	0.5761	0.5953	0.6146
67	1.1167	0.4484	0.4679	0.4874	0.5069	0.5264	0.5459	0.5654	0.5849	0.6044	0.6239
68	1.1333	0.4551	0.4749	0.4947	0.5145	0.5342	0.5540	0.5738	0.5936	0.6134	0.6332
69	1.1500	0.4618	0.4819	0.5019	0.5220	0.5421	0.5622	0.5823	0.6023	0.6224	0.6425
70	1.1667	0.4685	0.4888	0.5092	0.5296	0.5500	0.5703	0.5907	0.6111	0.6314	0.6518
71	1.1833	0.4752	0.4958	0.5165	0.5371	0.5578	0.5785	0.5991	0.6198	0.6404	0.6611
72	1.2000	0.4819	0.5028	0.5238	0.5447	0.5657	0.5866	0.6076	0.6285	0.6495	0.6704
73	1.2167	0.4886	0.5098	0.5310	0.5523	0.5735	0.5948	0.6160	0.6372	0.6585	0.6797
74	1.2333	0.4952	0.5168	0.5383	0.5598	0.5814	0.6029	0.6244	0.6460	0.6675	0.6890
75	1.2500	0.5019	0.5238	0.5456	0.5674	0.5892	0.6111	0.6329	0.6547	0.6765	0.6983
76	1.2667	0.5086	0.5307	0.5529	0.5750	0.5971	0.6192	0.6413	0.6634	0.6855	0.7077
77	1.2833	0.5153	0.5377	0.5601	0.5825	0.6049	0.6273	0.6497	0.6722	0.6946	0.7170
78	1.3000	0.5220	0.5447	0.5674	0.5901	0.6128	0.6355	0.6582	0.6809	0.7036	0.7263
79	1.3167	0.5287	0.5517	0.5747	0.5977	0.6206	0.6436	0.6666	0.6896	0.7126	0.7356
80	1.3333	0.5354	0.5587	0.5819	0.6052	0.6285	0.6518	0.6751	0.6983	0.7216	0.7449
81	1.3500	0.5421	0.5657	0.5892	0.6128	0.6364	0.6599	0.6835	0.7071	0.7306	0.7542
82	1.3667	0.5488	0.5726	0.5965	0.6204	0.6442	0.6681	0.6919	0.7158	0.7397	0.7635
83	1.3833	0.5555	0.5796	0.6038	0.6279	0.6521	0.6762	0.7004	0.7245	0.7487	0.7728
84	1.4000	0.5622	0.5866	0.6110	0.6355	0.6599	0.6844	0.7088	0.7332	0.7577	0.7821
85	1.4167	0.5688	0.5936	0.6183	0.6430	0.6678	0.6925	0.7172	0.7420	0.7667	0.7914
86	1.4333	0.5755	0.6006	0.6256	0.6506	0.6756	0.7007	0.7257	0.7507	0.7757	0.8007
87	1.4500	0.5822	0.6075	0.6329	0.6582	0.6835	0.7088	0.7341	0.7594	0.7847	0.8101
88	1.4667	0.5889	0.6145	0.6401	0.6657	0.6913	0.7169	0.7426	0.7682	0.7938	0.8194
89	1.4833	0.5956	0.6215	0.6474	0.6733	0.6992	0.7251	0.7510	0.7769	0.8028	0.8287
90	1.5000	0.6023	0.6285	0.6547	0.6809	0.7070	0.7332	0.7594	0.7856	0.8118	0.8380
91	1.5167	0.6090	0.6355	0.6619	0.6884	0.7149	0.7414	0.7679	0.7943	0.8208	0.8473
92	1.5333	0.6157	0.6425	0.6692	0.6960	0.7228	0.7495	0.7763	0.8031	0.8298	0.8566
93	1.5500	0.6224	0.6494	0.6765	0.7036	0.7306	0.7577	0.7847	0.8118	0.8389	0.8659
94	1.5667	0.6291	0.6564	0.6838	0.7111	0.7385	0.7658	0.7932	0.8205	0.8479	0.8752
95	1.5833	0.6358	0.6634	0.6910	0.7187	0.7463	0.7740	0.8016	0.8292	0.8569	0.8845
96	1.6000	0.6424	0.6704	0.6983	0.7262	0.7542	0.7821	0.8100	0.8380	0.8659	0.8938
97	1.6167	0.6491	0.6774	0.7056	0.7338	0.7620	0.7903	0.8185	0.8467	0.8749	0.9031
98	1.6333	0.6558	0.6843	0.7129	0.7414	0.7699	0.7984	0.8269	0.8554	0.8839	0.9125
99	1.6500	0.6625	0.6913	0.7201	0.7489	0.7777	0.8065	0.8353	0.8642	0.8930	0.9218
100	1.6667	0.6692	0.6983	0.7274	0.7565	0.7856	0.8147	0.8438	0.8729	0.9020	0.9311