



## 360° MOMENTUM

Find the Speeds of vehicles colliding at an angle using Momentum.

**CASE NUMBER:** A Sample Recon Case

12/21/2021

$$V_2 = \frac{W_1 \times V_3 \times \sin\Theta}{W_2 \times \sin\Psi} + \frac{V_4 \times \sin\Phi}{\sin\Psi}$$

$$V_2 = \frac{4000.00 \times 17.66 \times 0.31}{3931.00 \times 0.41} + \frac{19.06 \times 0.60}{0.41}$$

$$V_2 = \frac{22004.36}{1649.84} + \frac{11.56}{0.41}$$

$$V_2 = 13.33 + 27.54$$

$$V_2 = \mathbf{40.87}$$

*V<sub>1</sub> = The Speed of Veh 1 in mph.  
V<sub>2</sub> = The Speed of Veh 2 in mph.  
V<sub>3</sub> = The Spd After Impact, Veh 1.  
V<sub>4</sub> = The Spd After Impact, Veh 2.  
W<sub>1</sub> = The Wt of Veh 1 in pounds.  
W<sub>2</sub> = The Wt of Veh 2 in pounds.  
Θ = The Departure Angle(°), Veh 1.  
Φ = The Departure Angle(°), Veh 2.  
Ψ = The Approach Angle(°), Veh 2.*

$$V_1 = V_3 \times \cos\Theta + \frac{W_2 \times V_4 \times \cos\Phi}{W_1} - \frac{W_2 \times V_2 \times \cos\Psi}{W_1}$$

$$V_1 = 17.66 \times 0.95 + \frac{3931.00 \times 19.06 \times 0.79}{4000.00} - \frac{3931.00 \times 40.87 \times -0.90}{4000.00}$$

$$V_1 = 17.66 \times 0.95 + \frac{59550.27}{4000.00} - \frac{-145814.98}{4000.00}$$

$$V_1 = 16.78 + 14.88 - -36.45$$

$$V_1 = \mathbf{68.11}$$

## TESTING

**Formula Inputs:**

The Wt of Veh 1 (lbs) is: 4000.00  
 The After Impact Speed of Veh 1 is: 17.66  
 The Depart Angle (°) Veh 1 is: 18.15  
 The Wt of Veh 2 (lbs) is: 3931.00  
 The After Impact Speed of Veh 2 is: 19.06  
 The Depart Angle (°) Veh 2 is: 37.36  
 The Angle of Approach (°) is: 155.18

**Formula Results:**

The Spd of Veh 1 in mph is: 68.11  
 The Vel of Veh 1 in fps is: 99.84  
 The Spd of Veh 2 in mph is: 40.87  
 The Vel of Veh 2 in fps is: 59.91  
 $\Delta V_1$  (mph/kph) is: 51.62  
 $\Delta V_2$  (mph/kph) is: 52.54  
 The Longitudinal  $\Delta V_1$  is: -51.33  
 The Longitudinal  $\Delta V_2$  is: -49.63  
 $V_1$  Mean G Force (g's) is: 23.50  
 $V_2$  Mean G Force (g's) is: 23.92  
 Energy Absorbed (ft-lbs/kg-m) is: 749712.80  
 The Coefficient of Restitution is: -0.02

**Vector Sum Analysis Info:**

<u>ITEM</u>	<u>MPH-LB</u>
$W_1V_1$	272440.00
$W_2V_2$	160659.97
$W_1V_1+W_2V_2^*$	143460.07
$V_1$ PDOF/ $\Delta P$	206490.56
$W_1V_3$	70640.00
$W_2V_4$	74924.86
$W_1V_3+W_2V_4^*$	143526.03
$V_2$ PDOF/ $\Delta P$	206545.35

\* Note that these are VECTORAL additions.

PDOF<sub>1</sub> = 173.89° (E to G = 6.11°)  
 PDOF<sub>2</sub> = 353.89° (F to H = 18.71°)

**Vector Sum Analysis Diagram:**

<u>INCHES</u>	<u>DEGREES</u>
3.00	0.00°
1.76	155.18°
1.57	28.04°
2.27	173.89°
0.77	18.15°
0.82	37.36°
1.58	28.04°
2.27	353.89°

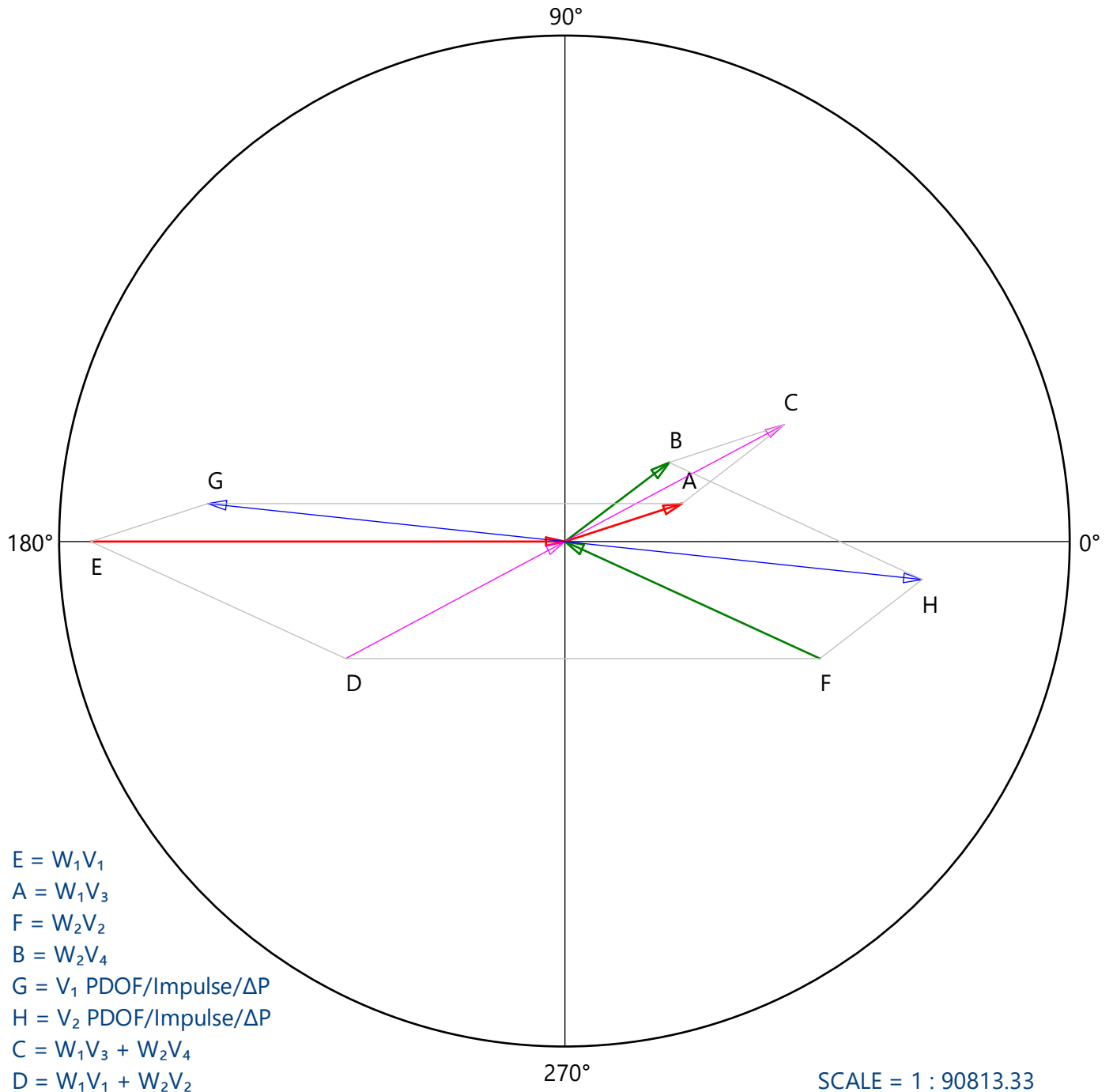
Scale of Diagram: 1 inch = 90813.33 mph-lb.

**Calculation Notes:**

adgsdfbsdfb  
 sfdb  
 sgb  
 strgh  
 erth  
 eryj  
 sfb  
 sdfg  
 werg

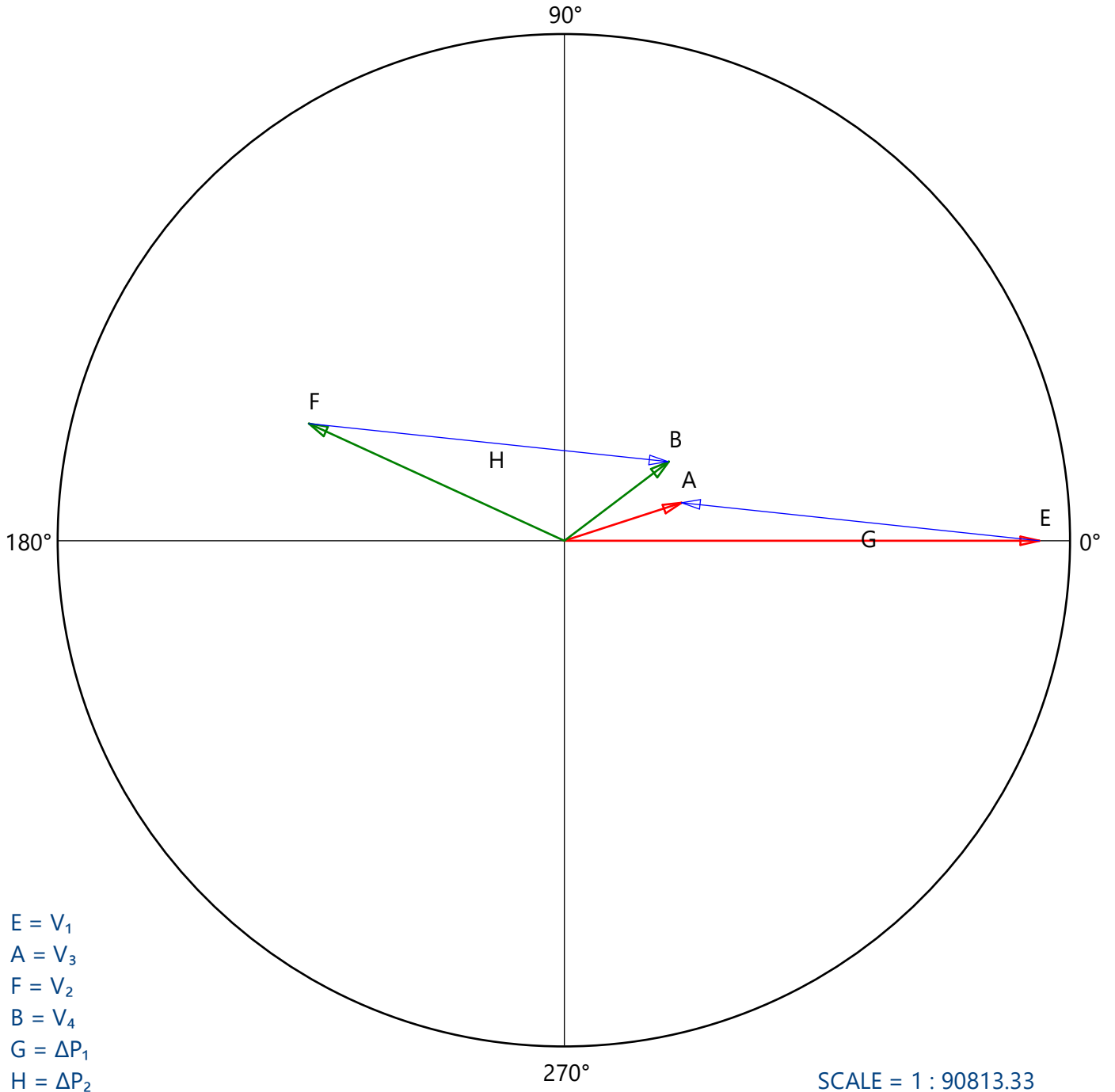
**TESTING**

**Vector Sum Analysis (Type A):**



**TESTING**

**Vector Sum Analysis (Type B):**



**TESTING**

## Incrementation Results

<u>V<sub>1</sub> Wt</u>	<u>V<sub>2</sub> Spd</u>	<u>V<sub>1</sub> Spd</u>	<u>V<sub>1</sub> Wt</u>	<u>V<sub>2</sub> Spd</u>	<u>V<sub>1</sub> Spd</u>	<u>V<sub>1</sub> Wt</u>	<u>V<sub>2</sub> Spd</u>	<u>V<sub>1</sub> Spd</u>
3850.00	40.37	69.65	3900.00	40.54	69.12	3950.00	40.71	68.62
3851.00	40.38	69.65	3901.00	40.54	69.11	3951.00	40.71	68.61
3852.00	40.38	69.63	3902.00	40.55	69.11	3952.00	40.71	68.59
3853.00	40.38	69.62	3903.00	40.55	69.09	3953.00	40.72	68.59
3854.00	40.39	69.62	3904.00	40.55	69.08	3954.00	40.72	68.58
3855.00	40.39	69.60	3905.00	40.56	69.07	3955.00	40.72	68.56
3856.00	40.39	69.59	3906.00	40.56	69.06	3956.00	40.73	68.56
3857.00	40.40	69.58	3907.00	40.56	69.05	3957.00	40.73	68.54
3858.00	40.40	69.57	3908.00	40.57	69.04	3958.00	40.73	68.53
3859.00	40.40	69.56	3909.00	40.57	69.03	3959.00	40.74	68.53
3860.00	40.41	69.55	3910.00	40.57	69.02	3960.00	40.74	68.51
3861.00	40.41	69.54	3911.00	40.58	69.01	3961.00	40.74	68.50
3862.00	40.41	69.52	3912.00	40.58	69.00	3962.00	40.75	68.50
3863.00	40.42	69.52	3913.00	40.58	68.98	3963.00	40.75	68.48
3864.00	40.42	69.51	3914.00	40.59	68.98	3964.00	40.75	68.47
3865.00	40.42	69.49	3915.00	40.59	68.98	3965.00	40.76	68.46
3866.00	40.43	69.49	3916.00	40.59	68.96	3966.00	40.76	68.45
3867.00	40.43	69.47	3917.00	40.60	68.96	3967.00	40.76	68.44
3868.00	40.43	69.46	3918.00	40.60	68.94	3968.00	40.77	68.43
3869.00	40.44	69.46	3919.00	40.60	68.93	3969.00	40.77	68.42
3870.00	40.44	69.44	3920.00	40.61	68.93	3970.00	40.77	68.41
3871.00	40.44	69.43	3921.00	40.61	68.91	3971.00	40.78	68.40
3872.00	40.45	69.42	3922.00	40.61	68.90	3972.00	40.78	68.39
3873.00	40.45	69.41	3923.00	40.62	68.89	3973.00	40.78	68.38
3874.00	40.45	69.40	3924.00	40.62	68.88	3974.00	40.79	68.38
3875.00	40.46	69.39	3925.00	40.62	68.87	3975.00	40.79	68.37
3876.00	40.46	69.38	3926.00	40.63	68.86	3976.00	40.79	68.35
3877.00	40.46	69.36	3927.00	40.63	68.85	3977.00	40.80	68.35
3878.00	40.47	69.36	3928.00	40.63	68.84	3978.00	40.80	68.33
3879.00	40.47	69.35	3929.00	40.64	68.83	3979.00	40.80	68.32
3880.00	40.47	69.33	3930.00	40.64	68.82	3980.00	40.81	68.32
3881.00	40.48	69.33	3931.00	40.64	68.80	3981.00	40.81	68.30
3882.00	40.48	69.32	3932.00	40.65	68.80	3982.00	40.81	68.29
3883.00	40.48	69.30	3933.00	40.65	68.79	3983.00	40.82	68.29
3884.00	40.49	69.30	3934.00	40.65	68.77	3984.00	40.82	68.27
3885.00	40.49	69.28	3935.00	40.66	68.77	3985.00	40.82	68.26
3886.00	40.49	69.27	3936.00	40.66	68.75	3986.00	40.83	68.25
3887.00	40.50	69.27	3937.00	40.66	68.74	3987.00	40.83	68.24
3888.00	40.50	69.25	3938.00	40.67	68.74	3988.00	40.83	68.23
3889.00	40.50	69.24	3939.00	40.67	68.72	3989.00	40.84	68.22
3890.00	40.51	69.23	3940.00	40.67	68.71	3990.00	40.84	68.21
3891.00	40.51	69.22	3941.00	40.68	68.71	3991.00	40.84	68.20
3892.00	40.51	69.21	3942.00	40.68	68.69	3992.00	40.85	68.19
3893.00	40.52	69.20	3943.00	40.68	68.68	3993.00	40.85	68.18
3894.00	40.52	69.19	3944.00	40.69	68.67	3994.00	40.85	68.17
3895.00	40.52	69.17	3945.00	40.69	68.66	3995.00	40.86	68.17
3896.00	40.53	69.17	3946.00	40.69	68.65	3996.00	40.86	68.16
3897.00	40.53	69.16	3947.00	40.70	68.64	3997.00	40.86	68.14
3898.00	40.53	69.14	3948.00	40.70	68.64	3998.00	40.87	68.14
3899.00	40.54	69.14	3949.00	40.70	68.62	3999.00	40.87	68.13

## TESTING

## Incrementation Results

<u>V<sub>1</sub> Wt</u>	<u>V<sub>2</sub> Spd</u>	<u>V<sub>1</sub> Spd</u>	<u>V<sub>1</sub> Wt</u>	<u>V<sub>2</sub> Spd</u>	<u>V<sub>1</sub> Spd</u>	<u>V<sub>1</sub> Wt</u>	<u>V<sub>2</sub> Spd</u>	<u>V<sub>1</sub> Spd</u>
4000.00	40.87	68.11	4050.00	41.04	67.63	4100.00	41.21	67.16
4001.00	40.88	68.11	4051.00	41.04	67.62	4101.00	41.21	67.15
4002.00	40.88	68.10	4052.00	41.05	67.61	4102.00	41.21	67.13
4003.00	40.88	68.08	4053.00	41.05	67.60	4103.00	41.22	67.13
4004.00	40.89	68.08	4054.00	41.05	67.58	4104.00	41.22	67.12
4005.00	40.89	68.06	4055.00	41.06	67.58	4105.00	41.22	67.10
4006.00	40.89	68.05	4056.00	41.06	67.57	4106.00	41.23	67.10
4007.00	40.90	68.05	4057.00	41.06	67.55	4107.00	41.23	67.08
4008.00	40.90	68.03	4058.00	41.07	67.55	4108.00	41.23	67.07
4009.00	40.90	68.02	4059.00	41.07	67.54	4109.00	41.24	67.07
4010.00	40.91	68.02	4060.00	41.07	67.53	4110.00	41.24	67.05
4011.00	40.91	68.00	4061.00	41.08	67.53	4111.00	41.24	67.05
4012.00	40.91	68.00	4062.00	41.08	67.52	4112.00	41.25	67.05
4013.00	40.92	67.99	4063.00	41.08	67.50	4113.00	41.25	67.03
4014.00	40.92	67.98	4064.00	41.09	67.50	4114.00	41.25	67.02
4015.00	40.92	67.97	4065.00	41.09	67.48	4115.00	41.26	67.02
4016.00	40.93	67.96	4066.00	41.09	67.47	4116.00	41.26	67.00
4017.00	40.93	67.95	4067.00	41.10	67.47	4117.00	41.26	66.99
4018.00	40.93	67.94	4068.00	41.10	67.45	4118.00	41.27	66.99
4019.00	40.94	67.93	4069.00	41.10	67.44	4119.00	41.27	66.97
4020.00	40.94	67.92	4070.00	41.11	67.44	4120.00	41.27	66.96
4021.00	40.94	67.90	4071.00	41.11	67.42	4121.00	41.28	66.96
4022.00	40.95	67.90	4072.00	41.11	67.41	4122.00	41.28	66.94
4023.00	40.95	67.89	4073.00	41.12	67.41	4123.00	41.28	66.94
4024.00	40.95	67.87	4074.00	41.12	67.40	4124.00	41.29	66.93
4025.00	40.96	67.87	4075.00	41.12	67.39	4125.00	41.29	66.92
4026.00	40.96	67.86	4076.00	41.13	67.38	4126.00	41.29	66.91
4027.00	40.96	67.84	4077.00	41.13	67.37	4127.00	41.30	66.90
4028.00	40.97	67.84	4078.00	41.13	67.36	4128.00	41.30	66.89
4029.00	40.97	67.83	4079.00	41.14	67.35	4129.00	41.30	66.88
4030.00	40.97	67.82	4080.00	41.14	67.34	4130.00	41.31	66.87
4031.00	40.98	67.82	4081.00	41.14	67.33	4131.00	41.31	66.86
4032.00	40.98	67.80	4082.00	41.15	67.32	4132.00	41.31	66.85
4033.00	40.98	67.79	4083.00	41.15	67.31	4133.00	41.32	66.84
4034.00	40.99	67.79	4084.00	41.15	67.30	4134.00	41.32	66.84
4035.00	40.99	67.77	4085.00	41.16	67.29	4135.00	41.32	66.83
4036.00	40.99	67.76	4086.00	41.16	67.28	4136.00	41.33	66.82
4037.00	41.00	67.76	4087.00	41.16	67.28	4137.00	41.33	66.81
4038.00	41.00	67.74	4088.00	41.17	67.27	4138.00	41.33	66.80
4039.00	41.00	67.73	4089.00	41.17	67.26	4139.00	41.34	66.79
4040.00	41.01	67.73	4090.00	41.17	67.24	4140.00	41.34	66.78
4041.00	41.01	67.71	4091.00	41.18	67.24	4141.00	41.34	66.77
4042.00	41.01	67.70	4092.00	41.18	67.23	4142.00	41.35	66.76
4043.00	41.02	67.69	4093.00	41.18	67.21	4143.00	41.35	66.75
4044.00	41.02	67.68	4094.00	41.19	67.21	4144.00	41.35	66.75
4045.00	41.02	67.68	4095.00	41.19	67.20	4145.00	41.36	66.74
4046.00	41.03	67.67	4096.00	41.19	67.18	4146.00	41.36	66.73
4047.00	41.03	67.66	4097.00	41.20	67.18	4147.00	41.36	66.71
4048.00	41.03	67.65	4098.00	41.20	67.17	4148.00	41.37	66.71
4049.00	41.04	67.64	4099.00	41.20	67.16	4149.00	41.37	66.70

## TESTING