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Engine Performance Characteristics

Motorsports Technology (4012)

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1 Introduction

1.1 Aims and Objectives

The aim of this experiment is to evaluate the performance characteristics of a Honda D16 internal combustion engine by using a dynamometer. This involves examining how different engine parameters such as torque, brake power, and fuel efficiency vary with engine speed to better understand real-world engine behaviour.

The objective is to calculate and analyse key performance metrics, including torque, brake power, brake mean effective pressure (BMEP), specific fuel consumption (SFC), and overall thermal efficiency.

2 Background

2.1 Dynamometer

The W230 eddy-current dynamometer is used to measure engine performance by absorbing power from an engine and converting it into heat energy. The system consists of a rotor connected to the engine, a magnetic field generated by a coil, and a cooling system. As the rotor spins, currents are induced in the dynamometer, creating a resistance force that absorbs the power. Torque is measured using a load cell, and a test stand controller regulates torque and speed, ensuring precise control over the engine.



*Figure 1 photo of the W230 Eddy current dynamometer
(photo taken by Student)*



Figure 2 photo of the control stand (photo taken by student)

2.2 Engine

The engine used to measure the data was a Honda D16 from a Honda CRX Civic. The CRX is a compact sports coupe produced by Honda between 1984 and 1991. It is known for its lightweight design, nimble handling, and fuel efficiency. The CRX came with multiple engine options, such as the D16 and D15, with both single overhead cams (SOHC) and dual overhead cams (DOHC), as well as Honda's variable valve timing system, known as VTEC.



Figure 3 Honda CRX (photo taken by Jessica Lynn Walker)



Figure 4 Photo of a Honda D16 engine (photo taken by Felipe Seifert)

3 Experimental procedure

3.1 Manual testing mode

- Select *Manual Mode* on the control screen.
- Configure:
- Throttle Control: Set to *Direct* (controlled from throttle box).
 - Dyno Mode: Set to *Manual* (manual adjustment of dyno current).
- Display Parameters:
- Left screen: RPM, Torque, Lambda, Fuel Flow
 - Right screen: Dyno Speed, Engine Speed, Sensor values
 - Centre: Real-time trend display

Operation

- Increase throttle — observe RPM rise.
- Increase dyno torque — observe RPM fall.
- Reduce torque — engine revs increase.
- Observe fuel flow (yellow trace), torque (blue), throttle feedback (%), and power output (red trace in kW)

4 Results

Table 1 shows the data that calculated by the student.

Torque	toqrue	Brake power	BMEP	Fuel Flow	SFC	Fuel Energy Input	Overall thermal Efficiency	Corrected Power
Nm	lbft	Watts	Bar	Kg/s	g/kwh	watts	%	Watts
83.4334904	61.5373845	8737.134683	1310570	0.000868267	0.35775573	38203.73333	22.86984522	8794.060403
83.82587866	61.82679523	9217.13676	1316734	0.000892933	0.348759065	39289.06667	23.45980076	9277.189873
84.58699766	62.3881678	9743.72265	1328689	0.000908967	0.335834682	39994.53333	24.36263618	9807.206668
85.01120118	62.70104426	10237.705	1335353	0.000897867	0.315727011	39506.13333	25.91421669	10304.4075
86.31807434	63.66494443	10847.04913	1355881	0.0009176	0.304539969	40374.4	26.8661556	10917.72173
87.70407776	64.6872081	11480.43693	1377652	0.000973717	0.305335069	42843.53333	26.79619546	11555.2363
89.31768269	65.87734201	12159.32362	1402999	0.000974333	0.288469993	42870.66667	28.36280506	12238.54618
91.20130947	67.26663383	12893.28137	1432587	0.000981733	0.274114859	43196.26667	29.8481382	12977.28595
93.21709197	68.7533987	13666.33946	1464251	0.001029833	0.271279666	45312.66667	30.1600865	13755.3808
94.45299261	69.66495224	14342.08667	1483664	0.001044633	0.26221289	45963.86667	31.20295944	14435.53076
95.43355536	70.38817821	14990.66782	1499067	0.00109335	0.262567355	48107.4	31.16083559	15088.33766
96.08862349	70.87133166	15596.68454	1509357	0.001149467	0.265317926	50576.53333	30.83778881	15698.30281
96.6457985	71.28228286	16193.15896	1518109	0.001182767	0.262948076	52041.73333	31.11571796	16298.66349
96.89134707	71.46339019	16741.62293	1521966	0.001217917	0.261892173	53588.33333	31.24117114	16850.7009
96.79671706	71.39359468	17232.09846	1520479	0.00123395	0.2577787524	54293.8	31.73861189	17344.37207
96.96395114	71.5169402	17769.57213	1523106	0.00127095	0.257486222	55921.8	31.77575137	17885.34758
97.55375718	71.95195882	18388.45001	1532371	0.001348033	0.263911314	59313.46667	31.00215018	18508.25768
97.83927878	72.16254875	18954.55483	1536856	0.00140785	0.267390084	61945.4	30.59880933	19078.05089

Table 2 Data that was given.

engine spec	
cylinder	4
cc	1600
displacemnt volume	0.0016
fuel density	0.74
calorific value	44000000
conversion for nm to lbft i	0.737562149
2 pi	6.283185307
diameter(m)	0.815776
Baro (mBar)	1018.9
Humidity (%)	46
Ambient temp (deg c)	27

4.1 Equations

$$\text{Torque (Nm)} = \text{Force (N)} \times \text{Distance(m)}$$

$$\text{Brake Power(W)} = \frac{2\pi \times \text{Torque} \times \text{Engine speed (Rpm)}}{60}$$

$$\text{Fuel Flow (kg/s)} = \frac{\text{Fuel Flow (l/min)} \times \text{Fuel Density (Kg/L)}}{60}$$

$$\text{Brake Mean Effective pressure (BMEP)} = \frac{(2 \times \pi \times \text{Torque (Nm)})}{\text{Displacement Volume (m}^3\text{)}}$$

$$\text{Specific Fuel consumption (SFC)} = \frac{\text{Fuel Flow rate(kg/s)}}{\text{Power (W)}}$$

$$\text{Fuel Energy input} = \text{Fuel flow (kg/s)} \times \text{Caloric value of fuel}$$

$$\text{overall thermal efficiency} = \left(\frac{\text{brake power}}{\text{Fuel Energy Input}} \right) \times 100$$

$$\text{corrected power (DIN standard 70020)}$$

$$\begin{aligned} &= \text{measured power (w)} \times \frac{1.01325}{\text{Ambient Pressure (bar)}} \\ &\times \sqrt{\frac{\text{Ambient temperature (k)}}{293(k)}} \end{aligned}$$

4.2 Specific Fuel Consumption vs Dyno speed

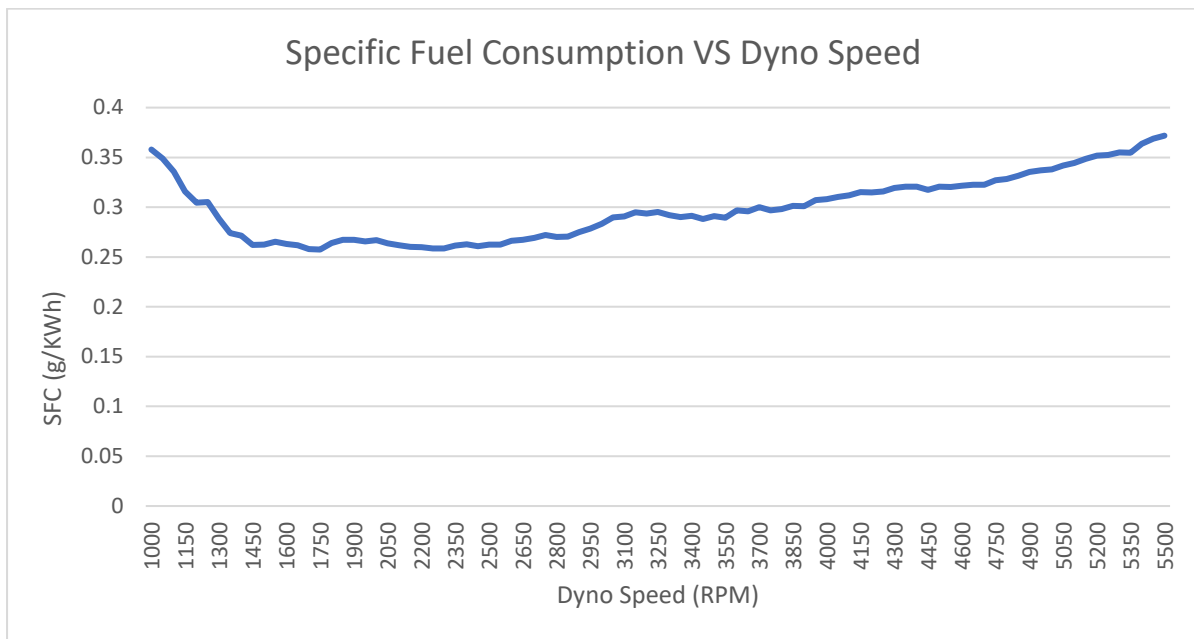


Figure 5 shows SFC (g/kWh) vs Dyno Speed (RPM)

Specific Fuel Consumption (SFC) is a measure of how efficiently and engine convert fuel into usable power. Its normally expressed in grams per kilowatt hour (g/kWh) and varies with engine speed dues to several factors such as combustion and friction. A lower SFC indicates better fuel efficiency.

The graph shows that at low engine speeds around 1000 Rpm, the SFC is high reaching around 0.36 g/kWh. At this Rpm air fuel mixture is poorly atomised due to low intake air velocity, leading to incomplete combustion and increased fuel consumption.

As the engine speed increases into the mid-range at around 2000 to 3000 rpm, SFC decreases a to about 0.25 g/kWh. This range is the most efficient operating condition for the engine. At this engine speed combustion is more complete. The engine generates more power per unit of fuel, resulting in optimal fuel efficiency.

At higher engine speeds above 4000 Rpm, SFC begin to rise, reaching around 0.37 g/kWh at 5500 rpm. This increase is caused by growing friction due to higher relative velocities and operating temperature. Also, combustion becomes less efficient because the intake and exhaust cycle occurs faster reducing the time for the cylinder to fill and for the fuel to completely burn.

4.3 Torque vs Dyno Speed

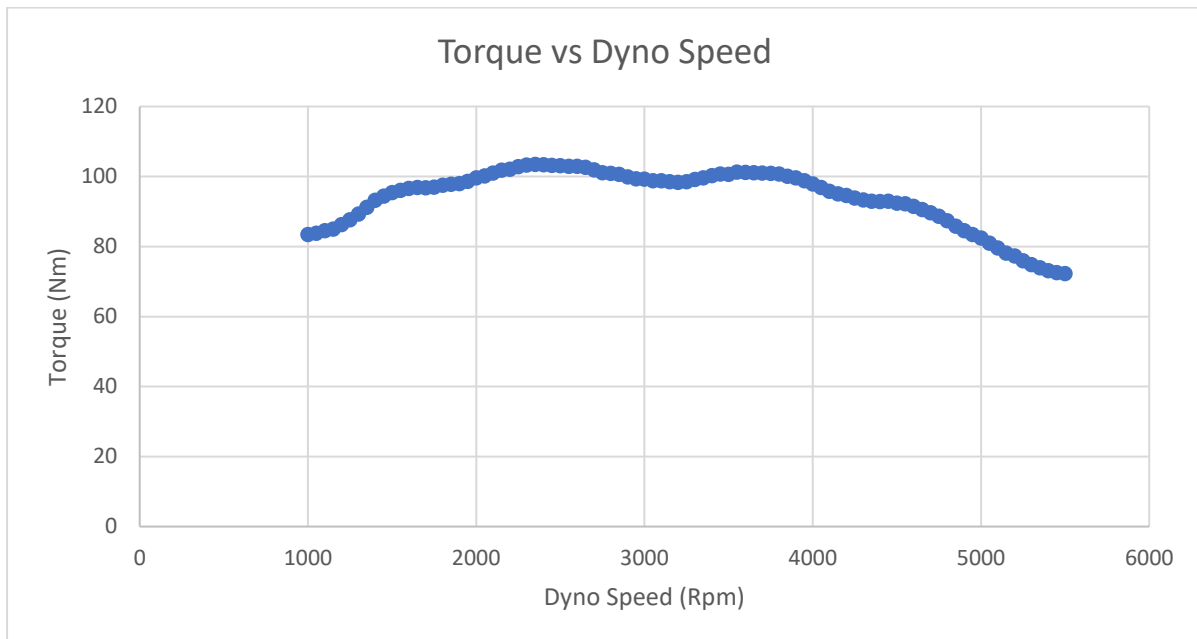


Figure 6 shows Torque vs Dyno speed

Torque is a key indicator of an engine performance, as it shows the engine's ability to produce rotational force. As shown in the Torque vs Dyno Speed graph, the torque increases at low Rpm, peaking in the mid-range and gradually decreases at higher speed.

At low dyno speeds between 1000 to 1500 rpm, torque starts at around 85 Nm, in this range, limited airflow and slow piston movement reduces the engine ability to fully fill the cylinder with air-fuel mixture. Additionally, combustion is less efficient, and practical losses take up a larger share of the engine's output. This factor contributes to lower torque at the lower Rpm.

As the engine reaches the mid-range at around 2000-3500 Rpm, torque increases and peaks around 100-103 Nm. This is the most efficient operating range of the engine, where volumetric efficiency is the highest. Combustion is more complete, and valve timing is more optimized. These conditions allow the engine to produce its maximum torque.

At higher Rpm, above 4000, torque begins to decline, falling below 80 Nm beyond 5000rpm. This drop is due to multiple factors, such as limitations in the intake and exhaust systems, increased friction and heat. These factors reduce overall efficiency and limits the engine ability to maintain high torque.

4.4 Brake Power vs Dyno Speed

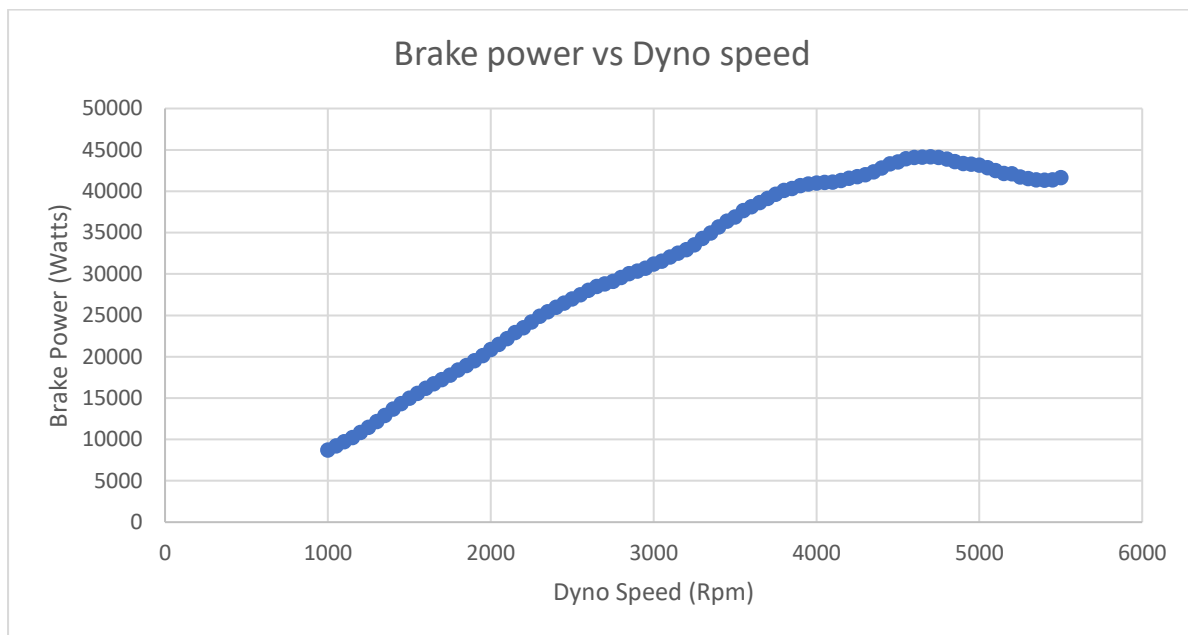


Figure 7 Brake power vs Dyno Speed

Brake Power (BP) refers to the actual output power available at the crankshaft and is a direct indicator of an engine's performance. It depends on both torque and engine speed.

The provided graphs shows that brake power increases steadily with Rpm, peaks around 4800 rpm, and then decline at higher Rpm.

At lower Rpm's below 1500, brake power is low, starting at about 9000 watts. This is due to the combination of low torque and low rotational speed as these Rpm, combustion is less efficient.

As the engine enters the mid-range around 1500-4000 Rpm, brake power increases rapidly. This is where torque is near its peak and engine speed is raising. Brake power climbs drastically to 40,000 watts at around 4000 Rpm.

Between 4000–4800 RPM, Brake Power continues to rise but at a slower rate. This is the range where torque begins to slightly decline, but the RPM is still increasing, balancing the output and pushing power to its peak—around 45,000 watts at approximately 4700–4800 RPM.

Beyond this point, at high engine speeds (above 4800 RPM), Brake Power starts to decline. This is due to a more noticeable drop in torque, reduced volumetric efficiency, and higher internal friction and thermal losses. These factors outweigh the benefits of increased engine speed, leading to a slight reduction in output power.

5 Conclusion

The data shows that the Honda D16 engine operates efficiently within a limited RPM range between 2000–3500 RPM for optimal torque and fuel economy, and around 4800 RPM for peak brake power. At low and high engine speeds, specific fuel consumption increases, and performance drops due to incomplete combustion, increased friction, and heat losses. These results highlight the inherent inefficiency of internal combustion engines, where a large portion of fuel energy is lost rather than converted into usable power.

6 Evaluation

While the analysis and graphs show clear trends, the experiment was affected by the non-functional dynamometer. Since getting primary data wasn't possible, pre-recorded data was used instead, limiting the hands-on experience. A future experiment using a fully operational dynamometer would provide a better understanding of the system and offer more practical, interactive learning opportunities.

7 Reference

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8 Appendix

Load	Dyno Speed	Fuel Flow Rate	Lambda	Torque	toqrue	Brake power	BMEP	Fuel Flow	SFC	Fuel Energy Input	Overall thermal Efficiency	Corrected Power
Newtons	Rpm	l/min	Lambda	Nm	lbft	Watts	Bar	Kg/s	g/kwh	watts	%	Watts
102.275	1000	0.0704	1.2658	83.4334904	61.5373845	8737.134683	1310570	0.000868267	0.35775573	38203.73333	22.86984522	8794.060403
102.756	1050	0.0724	1.26783	83.82587866	61.82679523	9217.13676	1316734	0.000892933	0.348759065	39289.06667	23.45980076	9277.189873
103.689	1100	0.0737	1.27344	84.58699766	62.3881678	9743.72265	1328689	0.000908967	0.335834682	39994.53333	24.36263618	9807.206668
104.209	1150	0.0728	1.28476	85.01120118	62.70104426	10237.705	1335353	0.000897867	0.315727011	39506.13333	25.91421669	10304.4075
105.811	1200	0.0744	1.29181	86.31807434	63.66494443	10847.04913	1355881	0.0009176	0.304539969	40374.4	26.8661556	10917.72173
107.51	1250	0.07895	1.29729	87.70407776	64.6872081	11480.43693	1377652	0.000973717	0.305335069	42843.53333	26.79619546	11555.2363
109.488	1300	0.079	1.29895	89.31768269	65.87734201	12159.32362	1402999	0.000974333	0.288469993	42870.66667	28.36280506	12238.54618
111.797	1350	0.0796	1.29469	91.20130947	67.26663383	12893.28137	1432587	0.000981733	0.274114859	43196.26667	29.8481382	12977.28595
114.268	1400	0.0835	1.2855	93.21709197	68.7533987	13666.33946	1464251	0.001029833	0.271279666	45312.66667	30.1600865	13755.3808
115.783	1450	0.0847	1.27818	94.45299261	69.66495224	14342.08667	1483664	0.001044633	0.26221289	45963.86667	31.20295944	14435.53076
116.985	1500	0.08865	1.2795	95.43355336	70.38817821	14990.66782	1499067	0.00109335	0.262567355	48107.4	31.16083559	15088.33766
117.788	1550	0.0932	1.27766	96.08862349	70.87133166	15596.68454	1509357	0.001149467	0.265317926	50576.53333	30.83778881	15698.30281
118.471	1600	0.0959	1.28235	96.6457985	71.28228286	16193.15896	1518109	0.001182767	0.262948076	52041.73333	31.11571796	16298.66349
118.772	1650	0.09875	1.29028	96.89134707	71.46339019	16741.62293	1521966	0.001217917	0.261892173	53588.33333	31.24117114	16850.7009
118.656	1700	0.10005	1.29942	96.79671706	71.39359468	17232.09846	1520479	0.00123395	0.257787524	54293.8	31.73861189	17344.37207
118.861	1750	0.10305	1.31053	96.96395114	71.5169402	17769.57213	1523106	0.00127095	0.257486222	55921.8	31.77575137	17885.34758
119.584	1800	0.1093	1.3149	97.55375718	71.95195882	18388.45001	1532371	0.001348033	0.263911314	59313.46667	31.00215018	18508.25768
119.934	1850	0.11415	1.31849	97.83927878	72.16254875	18954.55483	1536856	0.00140785	0.267390084	61945.4	30.59880933	19078.05089

120.176	1900	0.11745	1.31892	98.03669658	72.30815664	19506.11983	1539957	0.00144855	0.267340714	63736.2	30.60445999	19633.20954
120.948	1950	0.12055	1.31484	98.66647565	72.77265784	20148.04188	1549849	0.001486783	0.2656546	65418.46667	30.79870701	20279.31395
122.157	2000	0.12555	1.31653	99.65274883	73.50009561	20871.22291	1565342	0.00154845	0.26708641	68131.8	30.63359974	21007.20678
122.845	2050	0.12785	1.32098	100.2140027	73.91405524	21513.49094	1574158	0.001576817	0.263859548	69379.93333	31.00823236	21653.65943
123.796	2100	0.1309	1.32287	100.9898057	74.48625815	22208.81822	1586344	0.001614433	0.26169605	71035.06667	31.26458418	22353.51702
124.794	2150	0.13435	1.32164	101.8039501	75.08674028	22920.90217	1599133	0.001656983	0.260248918	72907.26667	31.43843298	23070.24047
125.137	2200	0.1377	1.31652	102.0837613	75.2931184	23518.41027	1603528	0.0016983	0.259961448	74725.2	31.47319816	23671.64156
126.028	2250	0.14105	1.30465	102.8106177	75.82922018	24224.1811	1614945	0.001739617	0.258527625	76543.13333	31.64775212	24382.01076
126.66	2300	0.14495	1.29646	103.3261882	76.20948542	24886.67418	1623044	0.001787717	0.258603458	78659.53333	31.63847168	25048.82022
126.822	2350	0.14985	1.28229	103.4583439	76.30695847	25460.21122	1625120	0.00184815	0.261323048	81318.6	31.30920998	25626.09408
126.69	2400	0.1537	1.27304	103.3506614	76.22753598	25974.8543	1623428	0.001895633	0.262726402	83407.86667	31.14197178	26144.09025
126.552	2450	0.15565	1.26984	103.2380844	76.14450338	26487.11394	1621660	0.001919683	0.260914044	84466.06667	31.35828976	26659.68745
126.438	2500	0.1596	1.27446	103.1450859	76.07591124	27003.32034	1620199	0.0019684	0.262421062	86609.6	31.17820697	27179.25713
126.239	2550	0.1626	1.27876	102.9827465	75.95617582	27500.03638	1617649	0.0020054	0.262524744	88237.6	31.16589343	27679.20946
126.161	2600	0.16805	1.27634	102.9191159	75.90924435	28021.92801	1616650	0.002072617	0.266270758	91195.13333	30.72743795	28204.50141
125.847	2650	0.17145	1.28027	102.6629623	75.72031511	28489.72671	1612626	0.00211455	0.267197368	93040.2	30.62087862	28675.348
124.911	2700	0.17465	1.28371	101.8993959	75.15713748	28811.37543	1600632	0.002154017	0.269145776	94776.73333	30.39920708	28999.09238
123.927	2750	0.1784	1.2812	101.0966724	74.56507895	29113.75162	1588023	0.002200267	0.272069368	96811.73333	30.07254454	29303.43867
123.689	2800	0.18005	1.27448	100.9025177	74.4218778	29586.16343	1584973	0.002220617	0.270201306	97707.13333	30.28045387	29778.92842
123.389	2850	0.1831	1.26036	100.6577849	74.24137215	30041.44696	1581129	0.002258233	0.270614129	99362.26667	30.23426092	30237.17829

122.519	2900	0.1879	1.2531	99.94805974	73.71790576	30352.95539	1569980	0.002317433	0.274858243	101967.0667	29.76741058	30550.71631
121.837	2950	0.19255	1.23943	99.39170051	73.30755625	30704.40989	1561241	0.002374783	0.278436226	104490.4667	29.38489115	30904.46067
121.709	3000	0.199	1.22735	99.28728118	73.23054051	31192.01932	1559601	0.002454333	0.283264764	107990.6667	28.88399551	31395.24706
121.123	3050	0.20605	1.2193	98.80923645	72.87795281	31559.20109	1552092	0.002541283	0.289887566	111816.4667	28.22410869	31764.82115
121.124	3100	0.21005	1.20692	98.81005222	72.87855449	32076.82986	1552105	0.002590617	0.290746313	113987.1333	28.14074618	32285.82248
120.851	3150	0.21605	1.19274	98.58734538	72.71429435	32520.7344	1548606	0.002664617	0.294969353	117243.1333	27.73785848	32732.61922
120.596	3200	0.21795	1.18481	98.3793225	72.56086455	32967.22739	1545339	0.00268805	0.29533329	118274.2	27.87355771	33182.02128
120.84	3250	0.22305	1.17378	98.57837184	72.70767581	33550.08462	1548465	0.00275095	0.29518316	121041.8	27.71776743	33768.67604
121.633	3300	0.2255	1.16118	99.22528221	73.18481241	34289.79594	1558627	0.002781167	0.291987739	122371.3333	28.02110184	34513.20686
122.181	3350	0.2285	1.15104	99.67232746	73.51453606	34966.16677	1565649	0.002818167	0.290149048	123999.3333	28.1986732	35193.9845
122.933	3400	0.2342	1.14117	100.285791	73.96700356	35706.47182	1575286	0.002888467	0.291221156	127092.5333	28.09486197	35939.11292
123.475	3450	0.23605	1.12669	100.7279416	74.2931171	36391.30855	1582231	0.002911283	0.287997888	128096.4667	28.40929926	36628.41162
123.428	3500	0.24195	1.11975	100.6896001	74.26483788	36904.66594	1581629	0.00298405	0.291090021	131298.2	28.10751856	37145.11372
124.205	3550	0.24545	1.10622	101.3234581	74.73234752	37667.5154	1591585	0.003027217	0.289320383	133197.5333	28.27943916	37912.93343
124.066	3600	0.25505	1.09697	101.2100652	74.64871323	38155.29568	1589804	0.003145617	0.296792878	138407.1333	27.5674344	38403.89179
123.967	3650	0.25755	1.09401	101.1293034	74.58914637	38654.36099	1588535	0.00317645	0.295832597	139763.8	27.65691902	38906.20869
123.815	3700	0.26445	1.09659	101.0053054	74.49769017	39135.82815	1586588	0.00326155	0.300021248	143508.2	27.27079578	39390.81279
123.767	3750	0.2651	1.09808	100.9661482	74.46880927	39649.31368	1585973	0.003269567	0.296863651	143860.9333	27.56086226	39907.64387
123.509	3800	0.2693	1.09907	100.755678	74.31357441	40094.21772	1582666	0.003321367	0.298220558	146140.1333	27.43545993	40355.44663
122.672	3850	0.27375	1.10533	100.0728735	73.80996364	40346.4862	1571941	0.00337625	0.301253	148555	27.15929198	40609.35873
122.157	3900	0.2759	1.11704	99.65274883	73.50009561	40698.88467	1565342	0.003402767	0.300990066	149721.7333	27.1830173	40964.05322
121.184	3950	0.28285	1.12259	98.85899878	72.91465562	40892.33607	1552874	0.003488483	0.307112315	153493.2667	26.64112697	41158.76502
120.004	4000	0.28455	1.12461	97.8963831	72.20466673	41006.74106	1537753	0.00350945	0.308096173	154415.8	26.5560526	41273.91541
118.734	4050	0.2871	1.1222	96.86034758	71.44052615	41079.92711	1521479	0.0035409	0.310303374	155799.6	26.36715827	41347.57829
117.442	4100	0.28895	1.12394	95.80636499	70.66314848	41134.55823	1504923	0.003563717	0.311888119	156803.5333	26.23318324	41402.56535
116.5	4150	0.29305	1.12233	95.037904	70.09636074	41302.23604	1492852	0.003614283	0.315029433	159028.4667	25.97159924	41571.33565
115.931	4200	0.2949	1.12179	94.57372746	69.75400169	41595.69784	1485561	0.0036371	0.314781592	160032.4	25.99204776	41866.70945
115.034	4250	0.29715	1.12456	93.84197638	69.2142898	41765.21234	1474066	0.00366485	0.315895916	161253.4	25.90036076	42037.32841
114.391	4300	0.3022	1.12278	93.31743242	68.82740602	42020.36829	1465827	0.003727133	0.319313717	163993.8667	25.62313405	42294.14679
114.016	4350	0.30605	1.11943	93.01151642	68.60177396	42369.62302	1461021	0.003774617	0.320716094	166083.1333	25.5109325	42645.67705
113.871	4400	0.3092	1.11986	92.8932289	68.51452956	42802.1272	1459163	0.003813467	0.320742937	167792.5333	25.50895821	43080.99916
113.985	4450	0.3099	1.11873	92.98622736	68.58312171	43331.85257	1460624	0.0038221	0.317539158	168172.4	25.76632822	43614.17589
113.306	4500	0.31445	1.11563	92.43231546	68.17457725	43557.70248	1451923	0.003878217	0.32053068	170641.5333	25.52585038	43841.4973
113.074	4550	0.3171	1.10953	92.24305542	68.03498622	43951.4993	1448951	0.0039109	0.32033583	172079.6	25.54137695	44237.85985
112.195	4600	0.3194	1.10569	91.52598832	67.50610466	44089.06379	1437687	0.003939267	0.321652555	173327.7333	25.43682014	44376.32062
111.061	4650	0.32055	1.09782	90.60089834	66.82379331	44117.82308	1423156	0.00395345	0.322600233	173951.8	25.36209633	44405.26729
109.973	4700	0.3207	1.09558	89.71333405	66.16915948	44155.36435	1409214	0.0039553	0.322476786	174033.2	25.37180512	44443.05316
108.654	4750	0.32485	1.08827	88.6373255	65.37553631	44089.87535	1392312	0.004006483	0.327134969	176285.2667	25.01052764	44377.13747

107.076	4800	0.32455	1.08396	87.35003098	64.42607659	43906.9145	1372091	0.004002783	0.328194777	176122.4667	24.92976355	44192.98456
105.24	4850	0.3257	1.08221	85.85226624	63.32138201	43603.57724	1348564	0.004016967	0.331648936	176746.5333	24.67011738	43887.67095
103.632	4900	0.3277	1.0846	84.54049843	62.35387173	43379.99544	1327959	0.004041633	0.335405291	177831.8667	24.39382561	43662.63243
102.335	4950	0.32845	1.08823	83.48243696	61.57348563	43274.18876	1311339	0.004050883	0.336994879	178238.8667	24.27876117	43556.13638
101.106	5000	0.3287	1.08687	82.47984826	60.83401415	43186.34756	1295590	0.004053967	0.337937353	178374.5333	24.21105006	43467.72286
99.3149	5050	0.32985	1.0891	81.01871186	59.75633525	42845.51132	1272639	0.00406815	0.34181737	178998.6	23.93622705	43124.66594
97.5815	5100	0.3297	1.09185	79.60464574	58.71337361	42514.51294	1250427	0.0040663	0.34432195	178917.2	23.76211619	42791.51099
95.8486	5150	0.33095	1.09407	78.19098751	57.67071281	42168.92648	1228221	0.004081717	0.348459902	179595.5333	23.47994168	42443.6729
94.8033	5200	0.3338	1.09346	77.33825686	57.04177095	42113.98526	1214826	0.004116867	0.3519192	181142.1333	23.24913839	42388.37372
93.0976	5250	0.3313	1.08804	75.94678774	56.015476	41753.92732	1192969	0.004086033	0.352295483	179785.4667	23.22430622	42025.96987
91.7886	5300	0.3324	1.08339	74.87893695	55.22786968	41558.91089	1176196	0.0040996	0.355123839	180382.4	23.03933803	41829.68283
90.5938	5350	0.3308	1.08007	73.90424779	54.50897584	41404.90581	1160885	0.004079867	0.35472898	179514.1333	23.06498382	41674.67435
89.6374	5400	0.3388	1.07895	73.12403962	53.93352383	41350.67022	1148630	0.004178533	0.363784188	183855.4667	22.49085707	41620.08539
88.9256	5450	0.3438	1.07923	72.54337027	53.50524409	41402.14564	1139509	0.0042402	0.368693935	186568.8	22.19135549	41671.89619
88.6474	5500	0.3488	1.08366	72.31642138	53.33785518	41651.26866	1135944	0.004301867	0.371818686	189282.1333	22.00486011	41922.64234