

Name:	
Enrolment No:	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, July 2020

Course: Catalysis and Catalytic Materials

Program: M.Tech (CE+PDE)

Course Code: CHPD7020

Semester: II

Time 03 hrs.

Max. Marks: 100

Instructions:

Part I

5 X 10 = 50 Marks

S. No.		Marks	CO
Q 1	Name the five steps involved in the mechanism of heterogeneous catalytic reaction and explain any two of them in detail.	10	CO1
Q 2	Explain the drivers of refinery catalyst's market and any one catalyst technology for the production of petrochemicals	10	CO2
Q 3	Arrive the active centers required to be present in hydrocracking catalyst based on the reaction mechanism. What are the important considerations in the catalyst design for hydrocracking and how do they affect the product profile?	10	CO3
Q 4	Describe a method each to determine the surface structure and surface elemental composition of the catalyst.	10	CO4
Q 5	Explain the three-way catalyst system for removing the air pollutants from the automobile exhaust. Why does it fail for lean-burn engines and what is the alternate system to overcome this failure?	10	CO5

Name:	 UPES UNIVERSITY WITH A PURPOSE
Enrolment No: R670219001	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2020

Course: Catalysis and Catalytic Materials

Semester: II

Program: M.Tech (CE+PDE)

Time 03 hrs.

Course Code: CHPD 7020

Max. Marks: 100

Instructions:


PART II

5 X 10 = 50 Marks

S. No.		Marks	CO
Q 1	Explain the catalyst and the catalytic cycle involved in the Cativa process for the manufacture of acetic acid.	10	CO1
Q 2	Synthesis of ZSM-5 is carried out by hydrothermal crystallization of gel of composition; 0.12 TEAOH 0.3 Na ₂ O 0.1 Al ₂ O ₃ SiO ₂ 250 H ₂ O. The volume of autoclave used is 250 ml and the volume of gel to be taken is 2/3 of the volume of the autoclave. Calculate the weight of following reactants to be taken to get the above gel composition; (i) Ludox HS-40 (ii) TEAOH (35% aqueous solution) (iii) NaOH (iv) Sodium aluminate (NaAlO ₂)	10	CO2
Q 3	Iron-Cobalt oxide (Fe ₂ O ₃ – Co ₂ O ₃) having Fe/Co atomic ratio of 2 is to be prepared from the following precursors; (i) Ferric sulphate (ii) Cobaltic chloride (iii) Sodium hydroxide. Calculate the amount of each of the above precursor to be taken for preparing 10 kg of iron-cobalt oxide.	10	CO3
Q 4	Write a review of research work reported on the advancement of catalysts for hydrotreating in the last 5 years.	10	CO5
Q 5	Calculate the Langmuir and BET surface area and pore size distribution (BJH) from the following adsorption isotherm data. The conversion factor for converting gaseous nitrogen volume to liquid nitrogen volume is 0.0015468.	10	CO4

Isotherm Tabular Report

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)	EI
0.048743627	33.773827	109.3431	
0.089994974	62.357647	127.9749	
0.100597153	69.704880	132.2190	
0.120895987	83.771523	140.1711	
0.138544771	96.002312	147.0246	
0.156134981	108.192909	153.8618	
0.188755016	130.799210	167.2097	
0.207775600	143.982330	175.6852	
0.225041095	155.949692	183.9027	
0.242061734	167.748199	192.6168	
0.259085122	179.549103	201.6848	
0.276352813	191.519806	211.1328	
0.294731365	204.260880	221.0229	
0.381837722	264.617401	261.2601	
0.431968862	299.348633	279.5613	
0.477556759	330.931702	291.7445	
0.518676957	359.419922	301.9523	
0.566115247	392.283661	313.4957	
0.611307073	423.590881	324.2174	
0.656341381	454.789490	334.0410	
0.700273772	485.223633	342.7152	
0.732539655	507.575104	348.6202	
0.765570958	530.456421	354.4478	
0.798460349	553.238892	360.1561	
0.831259046	575.958008	365.8705	
0.863923442	598.583557	371.8159	
0.896727938	621.305664	378.2202	
0.929138587	643.751953	385.6120	
0.992848842	687.846802	431.4402	
0.888728248	615.688721	378.5532	
0.799734329	554.025513	361.6383	
0.588928301	407.976349	326.3215	
0.497583460	344.688690	307.9881	
0.395528466	273.990540	269.4206	
0.296749635	205.564453	222.8697	
0.196357104	136.020523	170.0685	
0.097424424	67.487862	129.8742	

Name:	 UPES UNIVERSITY WITH A PURPOSE
Enrolment No: R670219002	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2020

Course: Catalysis and Catalytic Materials

Semester: II

Program: M.Tech (CE+PDE)

Time 03 hrs.

Course Code: CHPD 7020

Max. Marks: 100

Instructions:

PART II

5 X 10 = 50 Marks

S. No.		Marks	CO
Q 1	Explain the catalyst and the catalytic cycle involved in the Wacker process for the manufacture of acetaldehyde.	10	CO1
Q 2	Synthesis of ZSM-5 is carried out by hydrothermal crystallization of gel of composition; 0.1 TEAOH 0.25 Na ₂ O 0.1 Al ₂ O ₃ SiO ₂ 300 H ₂ O. The volume of autoclave used is 250 ml and the volume of gel to be taken is 2/3 of the volume of the autoclave. Calculate the weight of following reactants to be taken to get the above gel composition; (j) Ludox HS-40 (ii) TEAOH (40% aqueous solution) (iii) NaOH (iv) Sodium aluminate (NaAlO ₂)	10	CO2
Q 3	Iron-Cobalt oxide (Fe ₂ O ₃ – Co ₂ O ₃) having Fe/Co atomic ratio of 3 is to be prepared from the following precursors; (i) Ferric nitrate (ii) Cobaltic chloride (iii) Sodium hydroxide. Calculate the amount of each of the above precursor to be taken for preparing 20 kg of iron-cobalt oxide.	10	CO3
Q 4	Write a review of research work reported on the advancement of catalysts for hydrogenation of benzene to cyclohexane in the last 5 years.	10	CO5
Q 5	Calculate the Langmuir and BET surface area and pore size distribution (BJH) from the following adsorption isotherm data. The conversion factor for converting gaseous nitrogen volume to liquid nitrogen volume is 0.0015468.	10	CO4

Isotherm Tabular Rej

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)
0.050820679	35.367222	19.1516
0.089861072	62.536652	25.4175
0.102500493	71.332962	27.3858
0.119108006	82.890961	29.9377
0.136847726	95.236862	32.6481
0.153952644	107.141212	35.2482
0.187678796	130.613037	40.3583
0.206689275	143.843597	43.2388
0.224554329	156.277084	45.9450
0.242519164	168.780334	48.6677
0.260849869	181.538055	51.4452
0.280015397	194.876846	54.3563
0.298888200	208.012299	57.2192
0.388249416	270.205139	70.8861
0.433573474	301.750092	77.9185
0.477943760	332.631531	84.9369
0.522385480	363.562958	92.1215
0.566717493	394.418304	99.5135
0.611106868	425.315094	107.1980
0.655428896	456.164795	115.2688
0.699797302	487.047852	123.9148
0.732927511	510.108948	130.9104
0.765484364	532.772827	138.4253
0.797927956	555.358276	146.8222
0.830417901	577.977234	156.5699
0.862725754	600.471680	168.3418
0.895425874	623.241577	183.2691
0.926074616	644.531189	200.7214
0.993199963	691.109497	259.6099
0.897835606	624.660828	206.7785
0.802254257	558.096497	160.3115
0.602264845	418.945160	106.9726
0.496710439	345.509827	88.3022
0.392452985	272.980865	71.2846
0.300376733	208.930008	57.1110
0.201219795	139.957993	42.0129
0.100619331	69.984749	26.6169

Name:

Enrolment No: R670219004



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2020

Course: Catalysis and Catalytic Materials

Program: M.Tech (CE+PDE)

Course Code: CHPD 7020

Semester: II

Time 03 hrs.

Max. Marks: 100

Instructions:


PART II

5 X 10 = 50 Marks

S. No.		Marks	CO
Q 1	Explain the catalyst and the catalytic cycle involved in the hydroformylation of propylene to butyraldehyde.	10	CO1
Q 2	Synthesis of ZSM-12 is carried out by hydrothermal crystallization of gel of composition; 0.2 TEAOH 0.35 Na ₂ O 0.1 Al ₂ O ₃ SiO ₂ 350 H ₂ O. The volume of autoclave used is 350 ml and the volume of gel to be taken is 2/3 of the volume of the autoclave. Calculate the weight of following reactants to be taken to get the above gel composition; (i) Ludox HS-40 (ii) TEAOH (35% aqueous solution) (iii) NaOH (iv) Sodium aluminate (NaAlO ₂)	10	CO2
Q 3	Iron-Cobalt oxide (Fe ₂ O ₃ – Co ₂ O ₃) having Fe/Co atomic ratio of 4 is to be prepared from the following precursors; (i) Ferric sulphate (ii) Cobaltic chloride (iii) Potassium hydroxide. Calculate the amount of each of the above precursor to be taken for preparing 15 kg of iron-cobalt oxide.	10	CO3
Q 4	Write a review of research work reported on the advancement of catalysts for hydrocracking in the last 5 years.	10	CO5
Q 5	Calculate the Langmuir and BET surface area and pore size distribution (BJH) from the following adsorption isotherm data. The conversion factor for converting gaseous nitrogen volume to liquid nitrogen volume is 0.0015468.	10	CO4

Isotherm Tabular Rep

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)
0.051207066	35.647877	14.2377
0.089813603	62.521393	19.7658
0.102933739	71.651787	21.5837
0.119879017	83.445122	23.9129
0.137140565	95.456711	26.2650
0.154678135	107.660889	28.6376
0.188486837	131.187607	33.1866
0.207185874	144.198395	35.6929
0.225555350	156.977051	38.1549
0.243487967	169.452911	40.5593
0.261466174	181.959839	42.9656
0.281052571	195.582657	45.5956
0.299456143	208.384064	48.0668
0.389048283	270.714661	60.1687
0.433725788	301.790985	66.2746
0.478309102	332.803711	72.4268
0.522736607	363.701569	78.6277
0.567210278	394.629089	84.9303
0.611749070	425.599457	91.3349
0.656216659	456.511780	97.8566
0.700691304	487.432190	104.5162
0.733612310	510.313232	109.5795
0.766315251	533.040771	114.7652
0.799084203	555.805054	120.2020
0.831853996	578.567505	126.0180
0.864395839	601.169006	132.4065
0.896700109	623.586365	139.8952
0.928182535	645.411560	149.6108
0.989249286	687.673767	215.1395
0.899236827	625.101868	146.6665
0.798651628	555.180359	122.1127
0.593066425	412.268402	89.8628
0.492953555	342.675232	75.6976
0.404952328	281.501434	62.3049
0.293236058	203.842194	47.0192
0.205396100	142.780502	35.2193
0.100992753	70.204819	21.0833

Name:	 UPES UNIVERSITY WITH A PURPOSE
Enrolment No: R670219005	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2020

Course: Catalysis and Catalytic Materials
Program: M.Tech (CE+PDE)
Course Code: CHPD 7020

Semester: II
Time 03 hrs.
Max. Marks: 100

Instructions:

PART II

5 X 10 = 50 Marks

S. No.		Marks	CO
Q 1	Explain the catalyst and the catalytic cycle involved in the Monsanto process for the manufacture of acetic acid.	10	CO1
Q 2	Synthesis of ZSM-12 is carried out by hydrothermal crystallization of gel of composition; 0.27 TEAOH 0.35 Na ₂ O 0.1 Al ₂ O ₃ SiO ₂ 400 H ₂ O. The volume of autoclave used is 450 ml and the volume of gel to be taken is 2/3 of the volume of the autoclave. Calculate the weight of following reactants to be taken to get the above gel composition; (i) Ludox HS-40 (ii) TEAOH (35% aqueous solution) (iii) NaOH (iv) Sodium aluminate (NaAlO ₂)	10	CO2
Q 3	Iron-Cobalt oxide (Fe ₂ O ₃ – Co ₂ O ₃) having Fe/Co atomic ratio of 3.5 is to be prepared from the following precursors; (i) Ferric nitrate (ii) Cobaltic chloride (iii) Potassium hydroxide. Calculate the amount of each of the above precursor to be taken for preparing 25 kg of iron-cobalt oxide.	10	CO3
Q 4	Write a review of research work reported on the advancement of catalysts for alkylation unit of petroleum refinery in the last 5 years.	10	CO5
Q 5	Calculate the Langmuir and BET surface area and pore size distribution (BJH) from the following adsorption isotherm data. The conversion factor for converting gaseous nitrogen volume to liquid nitrogen volume is 0.0015468.	10	CO4

Isotherm Tabular Re

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)
0.047537057	33.003792	13.5714
0.091964237	63.849373	22.7758
0.099957030	69.399300	24.4187
0.121191488	84.142990	28.7530
0.139278945	96.701981	32.4260
0.156695207	108.795700	35.9682
0.189484871	131.563263	42.5917
0.209992426	145.803452	46.7507
0.228250952	158.482330	50.4462
0.245665961	170.575760	53.9780
0.263669900	183.078339	57.6211
0.281724965	195.617569	61.2855
0.300355998	208.556107	65.0716
0.389086834	270.171326	83.1240
0.433374715	300.926453	92.1955
0.477960090	331.888733	101.3687
0.522349286	362.717072	110.5569
0.566740156	393.545593	119.8127
0.611096440	424.350677	129.1569
0.655679011	455.313477	138.6476
0.700024232	486.114319	148.2269
0.732439709	508.629211	155.3180
0.765485462	531.582214	162.6520
0.798284357	554.366821	170.0571
0.831028311	577.111206	177.6307
0.863671709	599.789001	185.4646
0.896207141	622.392456	193.8203
0.928390591	644.755127	203.1714
0.989189109	687.024048	239.5906
0.889008064	617.476929	194.0715
0.794195430	551.633423	170.5860
0.587148660	407.830231	125.7192
0.487476156	338.604614	104.8647
0.401446006	278.851349	85.6469
0.293063917	203.569183	63.4109
0.202658211	140.771225	45.0231
0.100585139	69.868835	24.2436

Name:

Enrolment No: R670219008



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2020

Course: Catalysis and Catalytic Materials

Program: M.Tech (CE+PDE)

Course Code: CHPD 7020

Semester: II

Time 03 hrs.

Max. Marks: 100

Instructions:


PART II

5 X 10 = 50 Marks

S. No.		Marks	CO
Q 1	Explain the catalyst and the catalytic cycle involved in the Monsanto process for the manufacture of acetic acid.	10	CO1
Q 2	Synthesis of ZSM-5 is carried out by hydrothermal crystallization of gel of composition; 0.19 TEAOH 0.3 Na ₂ O 0.15 Al ₂ O ₃ SiO ₂ 380 H ₂ O. The volume of autoclave used is 500 ml and the volume of gel to be taken is 2/3 of the volume of the autoclave. Calculate the weight of following reactants to be taken to get the above gel composition; (i) Ludox HS-40 (ii) TEAOH (40% aqueous solution) (iii) NaOH (iv) Sodium aluminate (NaAlO ₂)	10	CO2
Q 3	Iron-Cobalt oxide (Fe ₂ O ₃ – Co ₂ O ₃) having Fe/Co atomic ratio of 2.5 is to be prepared from the following precursors; (i) Ferric chloride (ii) Cobaltic nitrate (iii) Potassium hydroxide. Calculate the amount of each of the above precursor to be taken for preparing 40 kg of iron-cobalt oxide.	10	CO3
Q 4	Write a review of research work reported on the advancement of catalysts for ethylation of benzene in the last 5 years.	10	CO5
Q 5	Calculate the Langmuir and BET surface area and pore size distribution (BJH) from the following adsorption isotherm data. The conversion factor for converting gaseous nitrogen volume to liquid nitrogen volume is 0.0015468.	10	CO4

Isotherm Tabular Rep

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)
0.049077224	33.963905	45.4888
0.092563293	64.056900	58.6417
0.100720511	69.701294	61.0267
0.120759243	83.567017	66.8593
0.138516396	95.853813	71.9928
0.156407364	108.233376	77.1271
0.189555741	131.169403	86.6065
0.208924633	144.570953	92.1134
0.227213056	157.223831	97.3002
0.244554208	169.220871	102.2195
0.262470634	181.616501	107.2755
0.280449805	194.054367	112.3588
0.298619216	206.623505	117.4701
0.388739266	268.975037	142.7155
0.433681586	300.065552	155.3021
0.478117374	330.806000	167.8491
0.522706156	361.649658	180.6020
0.567011048	392.297607	193.5578
0.611807377	423.282623	207.0413
0.655903907	453.782288	220.9399
0.700425651	484.572601	235.7987
0.733411673	507.383362	247.6092
0.766269945	530.102295	260.2945
0.798120445	552.120300	273.8787
0.830915734	574.790588	289.9925
0.863415377	597.249268	309.4211
0.894996164	619.064636	334.7706
0.925517456	640.083435	370.5109
0.989637974	684.080505	569.5910
0.902679145	623.717896	389.2148
0.798591843	551.671204	299.9526
0.586715766	405.297729	215.0369
0.491190337	339.309662	186.1446
0.396570198	273.946960	144.3146
0.293862990	202.997787	115.2701
0.192381692	132.895462	86.4785
0.100489562	69.417244	59.9661

Name:	 UPES UNIVERSITY WITH A PURPOSE
Enrolment No: R670219009	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2020

Course: Catalysis and Catalytic Materials

Semester: II

Program: M.Tech (CE+PDE)

Time 03 hrs.

Course Code: CHPD 7020

Max. Marks: 100

Instructions:

PART II

5 X 10 = 50 Marks

S. No.		Marks	CO
Q 1	Explain the catalyst and the catalytic cycle involved in the air oxidation of cyclohexane to cyclohexanone and cyclohexanol	10	CO1
Q 2	Synthesis of ZSM-5 is carried out by hydrothermal crystallization of gel of composition; 0.18 TEAOH 0.25 Na ₂ O 0.15 Al ₂ O ₃ SiO ₂ 380 H ₂ O. The volume of autoclave used is 400 ml and the volume of gel to be taken is 2/3 of the volume of the autoclave. Calculate the weight of following reactants to be taken to get the above gel composition; (i) Ludox HS-40 (ii) TEAOH (40% aqueous solution) (iii) NaOH (iv) Sodium aluminate (NaAlO ₂)	10	CO2
Q 3	Iron-Cobalt oxide (Fe ₂ O ₃ – Co ₂ O ₃) having Fe/Co atomic ratio of 3.5 is to be prepared from the following precursors; (i) Ferric nitrate (ii) Cobaltic chloride (iii) Potassium hydroxide. Calculate the amount of each of the above precursor to be taken for preparing 50 kg of iron-cobalt oxide.	10	CO3
Q 4	Write a review of research work reported on the advancement of catalysts for catalytic reforming in the last 5 years.	10	CO5
Q 5	Calculate the Langmuir and BET surface area and pore size distribution (BJH) from the following adsorption isotherm data. The conversion factor for converting gaseous nitrogen volume to liquid nitrogen volume is 0.0015468.	10	CO4

Isotherm Tabular Re

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)
0.053647931	36.708752	7.7009
0.089546347	61.272552	11.7961
0.103113008	70.555847	13.3340
0.120621195	82.536140	15.3144
0.138161672	94.538582	17.2916
0.156038807	106.771439	19.3083
0.189361094	129.572906	23.0615
0.209162895	143.122879	25.2950
0.227112225	155.405502	27.3162
0.245129232	167.734329	29.3483
0.263172271	180.081024	31.3896
0.281913643	192.905624	33.5069
0.300139081	205.377472	35.5687
0.388570312	265.889587	45.5827
0.433491429	296.628723	50.6981
0.478237878	327.248840	55.8031
0.522467498	357.515106	60.8820
0.567139498	388.084656	66.0301
0.611592179	418.504333	71.1752
0.655910166	448.831543	76.3390
0.700592155	479.408508	81.5891
0.733390210	501.853027	85.4843
0.765816568	524.043884	89.3855
0.798791433	546.609619	93.4091
0.831194735	568.784973	97.4486
0.864227066	591.390259	101.7126
0.896009538	613.141052	106.0622
0.928390907	635.301819	111.0101
0.989613753	677.212036	136.5492
0.888438524	607.983337	105.3906
0.794596379	543.766968	93.0834
0.588360463	402.635132	68.5717
0.504958424	345.560272	58.9333
0.399189182	273.178772	46.8102
0.298952251	204.583221	35.4161
0.199579964	136.579376	24.1675
0.100255884	68.608521	12.9297

Name:

Enrolment No: R670219010



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2020

Course: Catalysis and Catalytic Materials

Program: M.Tech (CE+PDE)

Course Code: CHPD 7020

Semester: II

Time 03 hrs.

Max. Marks: 100

Instructions:

PART II

5 X 10 = 50 Marks

S. No.		Marks	CO
Q 1	Explain the catalyst and the catalytic cycle involved in the olefin metathesis.	10	CO1
Q 2	Synthesis of ZSM-5 is carried out by hydrothermal crystallization of gel of composition; 0.25 TEAOH 0.2 Na ₂ O 0.1 Al ₂ O ₃ SiO ₂ 280 H ₂ O. The volume of autoclave used is 400 ml and the volume of gel to be taken is 2/3 of the volume of the autoclave. Calculate the weight of following reactants to be taken to get the above gel composition; (i) Ludox HS-40 (ii) TEAOH (40% aqueous solution) (iii) NaOH (iv) Sodium aluminate (NaAlO ₂)	10	CO2
Q 3	Iron-Cobalt oxide (Fe ₂ O ₃ – Co ₂ O ₃) having Fe/Co atomic ratio of 4.5 is to be prepared from the following precursors; (i) Ferric sulphate (ii) Cobaltic chloride (iii) Potassium hydroxide. Calculate the amount of each of the above precursor to be taken for preparing 100 kg of iron-cobalt oxide.	10	CO3
Q 4	Write a review of research work reported on the advancement of FCC catalysts in the last 5 years.	10	CO5
Q 5	Calculate the Langmuir and BET surface area and pore size distribution (BJH) from the following adsorption isotherm data. The conversion factor for converting gaseous nitrogen volume to liquid nitrogen volume is 0.0015468.	10	CO4

Isotherm Tabular Re

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (cm ³ /g STP)
0.051765330	35.691631	76.0478
0.090490018	62.388237	91.6102
0.102648263	70.767418	96.2092
0.119569759	82.430489	102.3925
0.136924716	94.391556	108.5802
0.154493333	106.497826	114.7047
0.188569413	129.983139	126.2717
0.207950692	143.337860	132.7548
0.225704430	155.569839	138.6598
0.243813674	168.045990	144.6408
0.262069636	180.624496	150.6397
0.281027777	193.684097	156.8570
0.299308724	206.276077	162.8399
0.388762439	267.912811	192.2507
0.433356946	298.630829	207.1496
0.479067619	330.118958	222.4747
0.523129583	360.464600	237.3249
0.567348571	390.920166	252.3176
0.611905666	421.601624	267.6024
0.656610828	452.387512	283.1497
0.700983498	482.936523	298.9179
0.734143962	505.758484	310.9065
0.766570014	528.072388	322.9768
0.799022893	550.409119	335.3944
0.832223753	573.252808	348.5672
0.865202644	595.941467	362.2307
0.897952844	618.463257	376.7295
0.930332710	640.727356	392.7707
0.994012439	684.560059	453.2821
0.884959505	609.457092	394.1728
0.785462740	540.935303	363.8329
0.593488598	408.725861	308.7091
0.501165696	345.144592	282.0222
0.402557227	277.234558	198.5031
0.293222486	201.937515	161.1842
0.189631185	130.595886	127.0949
0.102764909	70.772507	96.8861

