ชื่อ-สกุล_____ รหัส_____ section_____

มหาวิทยาลัยสงขลานครินทร์
คณะวิศวกรรมศาสตร์

การสอบปลายภาค ประจำภาคการศึกษาที่ 1 ปีการศึกษา 2552
วันที่ 28 กันยายน 2552 เวลา 09.00 – 12.00 น.
วิชา 215-342, 216-342 Mechanics of Fluids II ห้องสอบ R200

คำสั่ง

1. ข้อสอบมีทั้งหมด 7 ข้อ ให้ทำทุกข้อ
2. อนุญาตให้นำเครื่องคิดเลข และเอกสารทุกชนิดเข้าห้องสอบได้
3. ให้เขียนชื่อ-สกุล, รหัสนักศึกษา และ section ลงในข้อสอบทุกหน้า
4. ห้ามยืมอุปกรณ์ทุกชนิดในห้องสอบ

ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น และพักการเรียน 1 ภาคการศึกษา

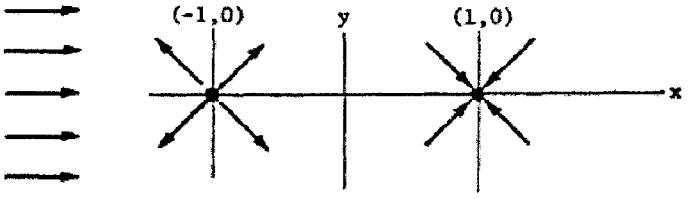
ข้อที่	คะแนนเต็ม	คะแนนที่ได้
1	10	
2	20	
3	10	
4	20	
5	20	
6	20	
7	20	
รวม	120(60%)	

ดร. กิตตินันท์ มลิวรรณ
(ผู้ออกข้อสอบ)

ชื่อ-สกุล_____รหัส_____section_____

1) A source discharging (q) 13 m^2/s is at (-1, 0) and a sink taking in 13 m^2/s is at (+1, 0). If a uniform flow with velocity 8 m/s from left to right is superimposed on the source-sink combination, what is the length of the resulting closed body contour? (10 points)

(Hint: $d \tan^{-1} u = \frac{du}{1+u^2}$)



ชื่อ-สกุล_____รหัส_____section_____

2) A source of strength (q) 8π is located at (2, 0). Another source of strength (q) 16π is located at (-3, 0). For the combined flow field produced by these two sources:

(a) find the location of the stagnation point;

(b) find the values of ψ at (0, 2) and at (-3, -1);

(c) find the velocity at (-2, 5). (20 points)

(Hint: $d \tan^{-1} u = \dfrac{du}{1+u^2}$)

3) Find the shear stress and the thickness of the boundary layer

(*a*) at the center and

(*b*) at the trailing edge of a smooth, flat plate 3.0 m wide and 0.6 m long parallel to the flow, immersed in 15°C water flowing at an undisturbed velocity of 0.9 m/s. Assume laminar boundary layer over the whole plate. Also,

(*c*) find the total friction drag on one side of the plate.

For water at 15°C: ρ = 999.1 kg/m^3, $\nu = 1.139\times10^{-6}$ m^2/s, μ = 0.001139 N·s/m^2(10 points)

ชื่อ-สกุล_____รหัส_____section_____

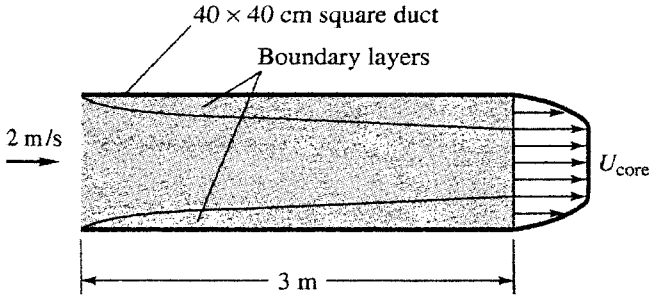
4) Air at 20°C and 1 atm enters a 40-cm-square duct. Using the "displacement thickness" concept, estimate

(*a*) the mean velocity and

(*b*) the mean pressure in the core of the flow at the position x = 3 m.

(*c*) What is the average gradient, in Pa/m in this section?

For air at 20°C: ρ = 1.2 kg/m^3, $\nu = 1.139\times10^{-6}$ m^2/s, $\mu = 1.8\times10^{-5}$ kg/m·s (20 points)



5) Compare the velocity of a 3-mm-diameter drop of water falling through standard air at sea level (T = 15°C), with that of a spherical bubble of air of the same size rising through water at the same temperature. Neglect the weight of the air.

For water at 15°C: ρ = 999.1 kg/m^3, ν = 1.139×10^{-6} m^2/s

For air at 15°C: ρ = 1.227 kg/m^3, ν = 1.455×10^{-5} m^2/s (20 points)

6) The stagnation pressure and temperature of air flowing past a probe are 120 kPa (abs) and 100°C, respectively. The air pressure is 80 kPa (abs). Determine the air speed and Mach number considering the flow to be

(*a*) incompressible;

(*b*) compressible. (20 points)

ชื่อ-สกุล_____รหัส_____section_____

7) Air flows isentropically through a duct with T_0 = 300°C. At two sections with identical area of 25 cm^2, the pressure are p_1 = 120 kPa and p_2 = 60 kPa. Determine

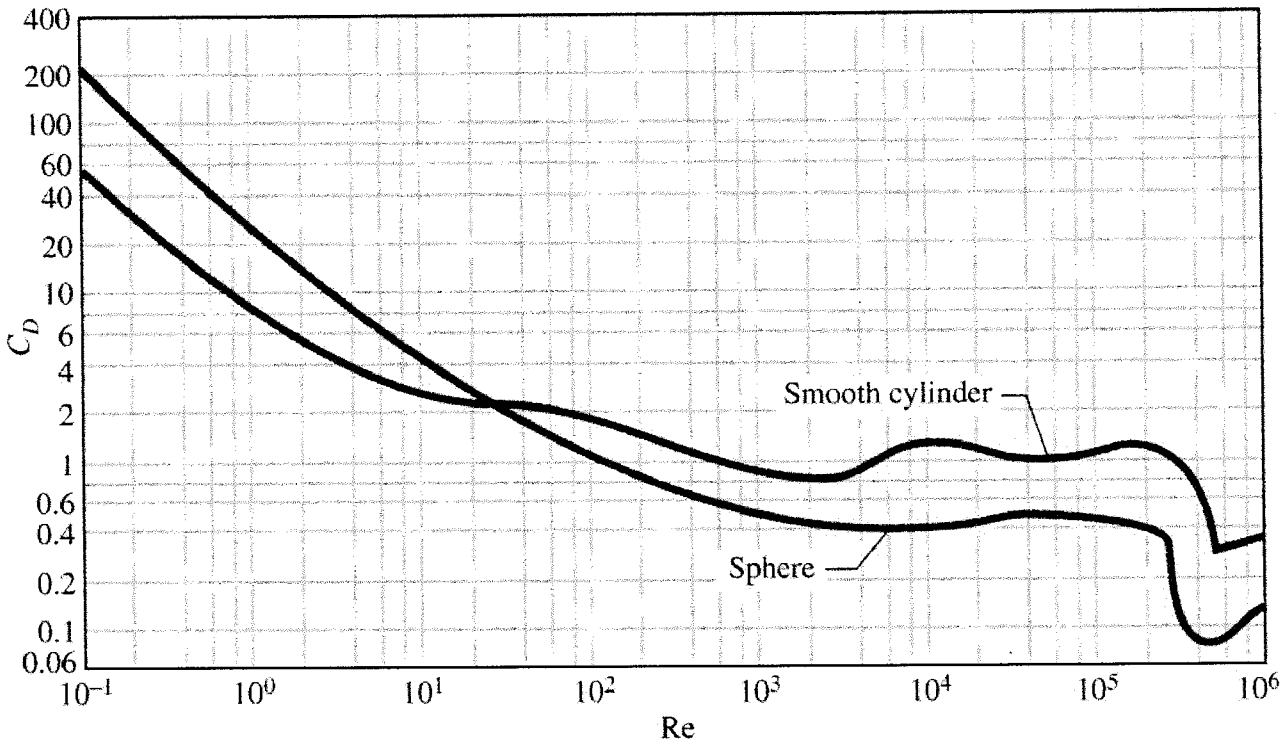
(*a*) the mass flow,

(*b*) the throat area, and

(*c*) Ma_2. (20 points)

ชื่อ-สกุล_____รหัส_____section_____

Drag coefficient as a function of Reynolds number for a smooth circular cylinder and a smooth sphere



ชื่อ-สกุล_____รหัส_____section_____

TABLE E.1 Isentropic Flow of an Ideal Gas ($k = 1.4$)

Ma	T/T_0	p/p_0	ρ/ρ_0	A/A^*	Ma	T/T_0	p/p_0	ρ/ρ_0	A/A^*
0	1.00000	1.00000	1.00000	∞	0.24	0.98861	0.96070	0.97177	2.4956
0.01	0.99998	0.99993	0.99995	57.874	0.25	0.98765	0.95745	0.96942	2.4027
0.02	0.99992	0.99972	0.99980	28.942	0.26	0.98666	0.95408	0.96699	2.3173
0.03	0.99982	0.99937	0.99955	19.300	0.27	0.98563	0.95060	0.96446	2.2385
0.04	0.99968	0.99888	0.99920	14.482	0.28	0.98456	0.94700	0.96185	2.1656
0.05	0.99950	0.99825	0.99875	11.592	0.29	0.98346	0.94329	0.95916	2.0979
0.06	0.99928	0.99748	0.99820	9.6659	0.30	0.98232	0.93947	0.95638	2.0351
0.07	0.99902	0.99658	0.99755	8.2915	0.31	0.98114	0.93554	0.95352	1.9765
0.08	0.99872	0.99553	0.99680	7.2616	0.32	0.97993	0.93150	0.95058	1.9218
0.09	0.99838	0.99435	0.99596	6.4613	0.33	0.97868	0.92736	0.94756	1.8707
0.10	0.99800	0.99303	0.99502	5.8218	0.34	0.97740	0.92312	0.94446	1.8229
0.11	0.99758	0.99157	0.99398	5.2992	0.35	0.97608	0.91877	0.94128	1.7780
0.12	0.99714	0.98998	0.99284	4.8643	0.36	0.97473	0.91433	0.93803	1.7358
0.13	0.99664	0.98826	0.99160	4.4968	0.37	0.97335	0.90979	0.93470	1.6961
0.14	0.99610	0.98640	0.99027	4.1824	0.38	0.97193	0.90516	0.93129	1.6587
0.15	0.99552	0.98441	0.98884	3.9103	0.39	0.97048	0.90044	0.92782	1.6234
0.16	0.99490	0.98228	0.98731	3.6727	0.40	0.96899	0.89562	0.92428	1.5901
0.17	0.99425	0.98003	0.98569	3.4635	0.41	0.96747	0.89071	0.92066	1.5587
0.18	0.99356	0.97765	0.98398	3.2779	0.42	0.96592	0.88572	0.91697	1.5289
0.19	0.99283	0.97514	0.98217	3.1122	0.43	0.96434	0.88065	0.91322	1.5007
0.20	0.99206	0.97250	0.98027	2.9635	0.44	0.96272	0.87550	0.90940	1.4740
0.21	0.99125	0.96973	0.97828	2.8293	0.45	0.96108	0.87027	0.90552	1.4487
0.22	0.99041	0.96685	0.97621	2.7076	0.46	0.95940	0.86496	0.90157	1.4246
0.23	0.98953	0.96383	0.97403	2.5968	0.47	0.95769	0.85958	0.89756	1.4018

TABLE E.1 (continued)

Ma	T/T_0	p/p_0	ρ/ρ_0	A/A^*	Ma	T/T_0	p/p_0	ρ/ρ_0	A/A^*
0.48	0.95595	0.85413	0.89349	1.3801	0.99	0.83611	0.53446	0.63923	1.00008
0.49	0.95418	0.84861	0.88936	1.3594	1.00	0.83333	0.52828	0.63394	1.00000
0.50	0.95238	0.84302	0.88517	1.3398	1.01	0.83055	0.52213	0.62866	1.00008
0.51	0.95055	0.83737	0.88092	1.3212	1.02	0.82776	0.51602	0.62339	1.00033
0.52	0.94869	0.83166	0.87662	1.3034	1.03	0.82496	0.50994	0.61813	1.00074
0.53	0.94681	0.82589	0.87227	1.2864	1.04	0.82215	0.50389	0.61288	1.00130
0.54	0.94489	0.82005	0.86788	1.2703	1.05	0.81933	0.49787	0.60765	1.00202
0.55	0.94295	0.81416	0.86342	1.2550	1.06	0.81651	0.49189	0.60243	1.00290
0.56	0.94098	0.80822	0.85892	1.2403	1.07	0.81368	0.48595	0.59722	1.00394
0.57	0.93898	0.80224	0.85437	1.2263	1.08	0.81084	0.48005	0.59203	1.00512
0.58	0.93696	0.79621	0.84977	1.2130	1.09	0.80800	0.47418	0.58685	1.00645
0.59	0.93491	0.79012	0.84513	1.2003	1.10	0.80515	0.46835	0.58169	1.00793
0.60	0.93284	0.78400	0.84045	1.1882	1.11	0.80230	0.46256	0.57655	1.00955
0.61	0.93074	0.77784	0.83573	1.1766	1.12	0.79944	0.45682	0.57143	1.01131
0.62	0.92861	0.77164	0.83096	1.1656	1.13	0.79657	0.45112	0.56632	1.01322
0.63	0.92646	0.76540	0.82616	1.1551	1.14	0.79370	0.44545	0.56123	1.01527
0.64	0.92428	0.75913	0.82132	1.1451	1.15	0.79083	0.43983	0.55616	1.01746
0.65	0.92208	0.75283	0.81644	1.1356	1.16	0.78795	0.43425	0.55112	1.01978
0.66	0.91986	0.74650	0.81153	1.1265	1.17	0.78507	0.42872	0.54609	1.02224
0.67	0.91762	0.74014	0.80659	1.1178	1.18	0.78218	0.42323	0.54108	1.02484
0.68	0.91535	0.73376	0.80162	1.1096	1.19	0.77929	0.41778	0.53610	1.02757
0.69	0.91306	0.72735	0.79662	1.1018	1.20	0.77640	0.41238	0.53114	1.03044
0.70	0.91075	0.72092	0.79158	1.09437	1.21	0.77350	0.40702	0.52620	1.03344
0.71	0.90842	0.71448	0.78652	1.08729	1.22	0.77061	0.40171	0.52129	1.03657
0.72	0.90606	0.70802	0.78143	1.08057	1.23	0.76771	0.39645	0.51640	1.03983
0.73	0.90368	0.70155	0.77632	1.07419	1.24	0.76481	0.39123	0.51154	1.04323
0.74	0.90129	0.69507	0.77119	1.06814	1.25	0.76190	0.38606	0.50670	1.04676
0.75	0.89888	0.68857	0.76603	1.06242	1.26	0.75900	0.38094	0.50189	1.05041
0.76	0.89644	0.68207	0.76086	1.05700	1.27	0.75610	0.37586	0.49710	1.05419
0.77	0.89399	0.67556	0.75567	1.05188	1.28	0.75319	0.37083	0.49234	1.05810
0.78	0.89152	0.66905	0.75046	1.04705	1.29	0.75029	0.36585	0.48761	1.06214
0.79	0.88903	0.66254	0.74524	1.04250	1.30	0.74738	0.36092	0.48291	1.06631
0.80	0.88652	0.65602	0.74000	1.03823	1.31	0.74448	0.35603	0.47823	1.07060
0.81	0.88400	0.64951	0.73474	1.03422	1.32	0.74158	0.35119	0.47358	1.07502
0.82	0.88146	0.64300	0.72947	1.03046	1.33	0.73867	0.34640	0.46895	1.07957
0.83	0.87890	0.63650	0.72419	1.02696	1.34	0.73577	0.34166	0.46436	1.08424
0.84	0.87633	0.63000	0.71890	1.02370	1.35	0.73287	0.33697	0.45980	1.08904
0.85	0.87374	0.62351	0.71361	1.02067	1.36	0.72997	0.33233	0.45527	1.09397
0.86	0.87114	0.61703	0.70831	1.01787	1.37	0.72707	0.32774	0.45076	1.09902
0.87	0.86852	0.61057	0.70300	1.01530	1.38	0.72418	0.32319	0.44628	1.10420
0.88	0.86589	0.60412	0.69769	1.01294	1.39	0.72128	0.31869	0.44183	1.10950
0.89	0.86324	0.59768	0.69237	1.01080	1.40	0.71839	0.31424	0.43742	1.1149
0.90	0.86058	0.59126	0.68704	1.00886	1.41	0.71550	0.30984	0.43304	1.1205
0.91	0.85791	0.58486	0.68171	1.00713	1.42	0.71261	0.30549	0.42869	1.1262
0.92	0.85523	0.57848	0.67639	1.00560	1.43	0.70973	0.30119	0.42436	1.1320
0.93	0.85253	0.57212	0.67107	1.00426	1.44	0.70685	0.29693	0.42007	1.1379
0.94	0.84982	0.56578	0.66575	1.00311	1.45	0.70397	0.29272	0.41581	1.1440
0.95	0.84710	0.55946	0.66044	1.00214	1.46	0.70110	0.28856	0.41158	1.1502
0.96	0.84437	0.55317	0.65513	1.00136	1.47	0.69823	0.28445	0.40738	1.1565
0.97	0.84162	0.54691	0.64982	1.00076	1.48	0.69537	0.28039	0.40322	1.1629
0.98	0.83887	0.54067	0.64452	1.00033	1.49	0.69251	0.27637	0.39909	1.1695

ชื่อ-สกุล_____รหัส_____section_____

TABLE E.1 (continued)

Ma	T/T_0	p/p_0	ρ/ρ_0	A/A^*	Ma	T/T_0	p/p_0	ρ/ρ_0	A/A^*
1.50	0.68965	0.27240	0.39498	1.1762	2.01	0.55310	0.12583	0.22751	1.7017
1.51	0.68680	0.26848	0.39091	1.1830	2.02	0.55064	0.12389	0.22499	1.7160
1.52	0.68396	0.26461	0.38687	1.1899	2.03	0.54819	0.12198	0.22250	1.7305
1.53	0.68112	0.26078	0.38287	1.1970	2.04	0.54576	0.12009	0.22004	1.7452
1.54	0.67828	0.25700	0.37890	1.2042	2.05	0.54333	0.11823	0.21760	1.7600
1.55	0.67545	0.25326	0.37496	1.2115	2.06	0.54091	0.11640	0.21519	1.7750
1.56	0.67262	0.24957	0.37105	1.2190	2.07	0.53850	0.11460	0.21281	1.7902
1.57	0.66980	0.24593	0.36717	1.2266	2.08	0.53611	0.11282	0.21045	1.8056
1.58	0.66699	0.24233	0.36332	1.2343	2.09	0.53373	0.11107	0.20811	1.8212
1.59	0.66418	0.23878	0.35951	1.2422	2.10	0.53135	0.10935	0.20580	1.8369
1.60	0.66138	0.23527	0.35573	1.2502	2.11	0.52898	0.10766	0.20352	1.8529
1.61	0.65858	0.23181	0.35198	1.2583	2.12	0.52663	0.10599	0.20126	1.8690
1.62	0.65579	0.22839	0.34826	1.2666	2.13	0.52428	0.10434	0.19902	1.8853
1.63	0.65301	0.22501	0.34458	1.2750	2.14	0.52194	0.10272	0.19681	1.9018
1.64	0.65023	0.22168	0.34093	1.2835	2.15	0.51962	0.10113	0.19463	1.9185
1.65	0.64746	0.21839	0.33731	1.2922	2.16	0.51730	0.09956	0.19247	1.9354
1.66	0.64470	0.21515	0.33372	1.3010	2.17	0.51499	0.09802	0.19033	1.9525
1.67	0.64194	0.21195	0.33016	1.3099	2.18	0.51269	0.09650	0.18821	1.9698
1.68	0.63919	0.20879	0.32664	1.3190	2.19	0.51041	0.09500	0.18612	1.9873
1.69	0.63645	0.20567	0.32315	1.3282	2.20	0.50813	0.09352	0.18405	2.0050
1.70	0.63372	0.20259	0.31969	1.3376	2.21	0.50586	0.09207	0.18200	2.0229
1.71	0.63099	0.19955	0.31626	1.3471	2.22	0.50361	0.09064	0.17998	2.0409
1.72	0.62827	0.19656	0.31286	1.3567	2.23	0.50136	0.08923	0.17798	2.0592
1.73	0.62556	0.19361	0.30950	1.3665	2.24	0.49912	0.08784	0.17600	2.0777
1.74	0.62286	0.19070	0.30617	1.3764	2.25	0.49689	0.08648	0.17404	2.0964
1.75	0.62016	0.18782	0.30287	1.3865	2.26	0.49468	0.08514	0.17211	2.1154
1.76	0.61747	0.18499	0.29959	1.3967	2.27	0.49247	0.08382	0.17020	2.1345
1.77	0.61479	0.18220	0.29635	1.4071	2.28	0.49027	0.08252	0.16830	2.1538
1.78	0.61211	0.17944	0.29314	1.4176	2.29	0.48809	0.08123	0.16643	2.1734
1.79	0.60945	0.17672	0.28997	1.4282	2.30	0.48591	0.07997	0.16458	2.1931
1.80	0.60680	0.17404	0.28682	1.4390	2.31	0.48374	0.07873	0.16275	2.2131
1.81	0.60415	0.17140	0.28370	1.4499	2.32	0.48158	0.07751	0.16095	2.2333
1.82	0.60151	0.16879	0.28061	1.4610	2.33	0.47944	0.07631	0.15916	2.2537
1.83	0.59888	0.16622	0.27756	1.4723	2.34	0.47730	0.07513	0.15739	2.2744
1.84	0.59626	0.16369	0.27453	1.4837	2.35	0.47517	0.07396	0.15564	2.2953
1.85	0.59365	0.16120	0.27153	1.4952	2.36	0.47305	0.07281	0.15391	2.3164
1.86	0.59105	0.15874	0.26857	1.5069	2.37	0.47095	0.07168	0.15220	2.3377
1.87	0.58845	0.15631	0.26563	1.5188	2.38	0.46885	0.07057	0.15052	2.3593
1.88	0.58586	0.15392	0.26272	1.5308	2.39	0.46676	0.06948	0.14885	2.3811
1.89	0.58329	0.15156	0.25984	1.5429	2.40	0.46468	0.06840	0.14720	2.4031
1.90	0.58072	0.14924	0.25699	1.5552	2.41	0.46262	0.06734	0.14557	2.4254
1.91	0.57816	0.14695	0.25417	1.5677	2.42	0.46056	0.06630	0.14395	2.4479
1.92	0.57561	0.14469	0.25138	1.5804	2.43	0.45851	0.06527	0.14235	2.4706
1.93	0.57307	0.14247	0.24862	1.5932	2.44	0.45647	0.06426	0.14078	2.4936
1.94	0.57054	0.14028	0.24588	1.6062	2.45	0.45444	0.06327	0.13922	2.5168
1.95	0.56802	0.13813	0.24317	1.6193	2.46	0.45242	0.06229	0.13768	2.5403
1.96	0.56551	0.13600	0.24049	1.6326	2.47	0.45041	0.06133	0.13616	2.5640
1.97	0.56301	0.13390	0.23784	1.6461	2.48	0.44841	0.06038	0.13465	2.5880
1.98	0.56051	0.13184	0.23522	1.6597	2.49	0.44642	0.05945	0.13316	2.6122
1.99	0.55803	0.12981	0.23262	1.6735	2.50	0.44444	0.05853	0.13169	2.6367
2.00	0.55556	0.12780	0.23005	1.6875	2.51	0.44247	0.05763	0.13023	2.6615

TABLE E.1 (continued)

Ma	T/T_0	p/p_0	ρ/ρ_0	A/A^*	Ma	T/T_0	p/p_0	ρ/ρ_0	A/A^*
2.52	0.44051	0.05674	0.12879	2.6865	2.90	0.37286	0.03165	0.08489	3.8498
2.53	0.43856	0.05586	0.12737	2.7117	2.91	0.37125	0.03118	0.08398	3.8866
2.54	0.43662	0.05500	0.12597	2.7372	2.92	0.36965	0.03071	0.08308	3.9238
2.55	0.43469	0.05415	0.12458	2.7630	2.93	0.36806	0.03025	0.08218	3.9614
2.56	0.43277	0.05332	0.12321	2.7891	2.94	0.36648	0.02980	0.08130	3.9993
2.57	0.43085	0.05250	0.12185	2.8154	2.95	0.36490	0.02935	0.08043	4.0376
2.58	0.42894	0.05169	0.12051	2.8420	2.96	0.36333	0.02891	0.07957	4.0763
2.59	0.42705	0.05090	0.11918	2.8689	2.97	0.36177	0.02848	0.07872	4.1153
2.60	0.42517	0.05012	0.11787	2.8960	2.98	0.36022	0.02805	0.07788	4.1547
2.61	0.42330	0.04935	0.11658	2.9234	2.99	0.35868	0.02764	0.07705	4.1944
2.62	0.42143	0.04859	0.11530	2.9511	3.00	0.35714	0.02722	0.07623	4.2346
2.63	0.41957	0.04784	0.11403	2.9791	3.10	0.34223	0.02345	0.06852	4.6573
2.64	0.41772	0.04711	0.11278	3.0074	3.20	0.32808	0.02023	0.06165	5.1210
2.65	0.41589	0.04639	0.11154	3.0359	3.30	0.31466	0.01748	0.05554	5.6287
2.66	0.41406	0.04568	0.11032	3.0647	3.40	0.30193	0.01512	0.05009	6.1837
2.67	0.41224	0.04498	0.10911	3.0938	3.50	0.28986	0.01311	0.04523	6.7896
2.68	0.41043	0.04429	0.10792	3.1233	3.60	0.27840	0.01138	0.04089	7.4501
2.69	0.40863	0.04361	0.10674	3.1530	3.70	0.26752	0.00990	0.03702	8.1691
2.70	0.40684	0.04295	0.10557	3.1830	3.80	0.25720	0.00863	0.03355	8.9506
2.71	0.40505	0.04230	0.10442	3.2133	3.90	0.24740	0.00753	0.03044	9.7990
2.72	0.40327	0.04166	0.10328	3.2440	4.00	0.23810	0.00658	0.02766	10.719
2.73	0.40151	0.04102	0.10215	3.2749	4.10	0.22925	0.00577	0.02516	11.715
2.74	0.39976	0.04039	0.10104	3.3061	4.20	0.22085	0.00506	0.02292	12.792
2.75	0.39801	0.03977	0.09994	3.3376	4.30	0.21286	0.00445	0.02090	13.955
2.76	0.39627	0.03917	0.09885	3.3695	4.40	0.20525	0.00392	0.01909	15.210
2.77	0.39454	0.03858	0.09777	3.4017	4.50	0.19802	0.00346	0.01745	16.562
2.78	0.39282	0.03800	0.09671	3.4342	4.60	0.19113	0.00305	0.01597	18.018
2.79	0.39111	0.03742	0.09566	3.4670	4.70	0.18457	0.00270	0.01463	19.583
2.80	0.38941	0.03685	0.09462	3.5001	4.80	0.17832	0.00240	0.01343	21.264
2.81	0.38771	0.03629	0.09360	3.5336	4.90	0.17235	0.00213	0.01233	23.067
2.82	0.38603	0.03574	0.09259	3.5674	5.00	0.16667	$189(10)^{-5}$	0.01134	25.000
2.83	0.38435	0.03520	0.09158	3.6015	6.00	0.12195	$633(10)^{-6}$	0.00519	53.180
2.84	0.38268	0.03467	0.09059	3.6359	7.00	0.09259	$242(10)^{-6}$	0.00261	104.143
2.85	0.38102	0.03415	0.08962	3.6707	8.00	0.07246	$102(10)^{-6}$	0.00141	190.109
2.86	0.37937	0.03363	0.08865	3.7058	9.00	0.05814	$474(10)^{-7}$	0.000815	327.189
2.87	0.37773	0.03312	0.08769	3.7413	10.00	0.04762	$236(10)^{-7}$	0.000495	535.938
2.88	0.37610	0.03262	0.08674	3.7771	∞	0	0	0	∞
2.89	0.37448	0.03213	0.08581	3.8133					