Unit conversion:

1 slug $\frac{ft}{s^2}$ = 1 lbf

1 lbm 32.2 $\frac{ft}{s^2}$ = 1 lbf

1 Btu = 778 ft lbf

1 slug = 32.2 lbm

1 atm = 2116.2 lb/ft^2

1 ft/s = 0.681818 mph

°R = °F + 459.67

1 psi = 144 lb/ft^2

1 Pa = 0.0208854 lb/ft^2

1 in. = 0.0254 m

1 ft = 0.3048 m

1 lb = 4.448222 N

1 slug = 14.5939 kg

1 atm = 101325 Pa

1K = 1.8 °R

K = °C + 273.15

Constants:

Standard conditions:

P = 101325 Pa = 2116.2 lb/ft^2

T = 25 °C = 298.15 K = 77 °F = 536.67 °R

ρ = 1.22 [kg/m^3] = 0.00238 [$slug/ft^3$]

Gas constant:

R_u = 8.31446 J/mol·k

R = 287 J/kg·K = 1718 ft·lb/slug °R

Reference temperature: T_{ref} = 298 K

Air specific heat: C_p = 1004.5 [J/kg·K]

Isentropic flow.

$$\frac{T}{T_0} = \left(1 + \frac{\gamma-1}{2}M^2\right)^{-1}$$

$$\frac{P}{P_0} = \left(1 + \frac{\gamma-1}{2}M^2\right)^{\frac{-\gamma}{\gamma-1}}$$

$$\frac{\rho}{\rho_0} = \left(1 + \frac{\gamma-1}{2}M^2\right)^{\frac{-1}{\gamma-1}}$$

$$\frac{A}{A^*} = \frac{1}{M}\left[\frac{2}{\gamma+1}\left(1 + \frac{\gamma-1}{2}M^2\right)\right]^{\frac{\gamma+1}{2(\gamma-1)}}$$

HW 1:

$$I_{sp} = \frac{Thrust}{\dot{m}g} = \frac{V_{exit}\ [s]}{g}$$

$$TSFC = \frac{\dot{m}_f}{Thrust}$$ ← $\dot{m}_f$: lbm/hr, Thrust: lbf

$$\Delta V = I_{sp}\, g\, \ln\left(1 + \frac{m_{propellant}}{m_{dry}}\right)$$

$$T = (\dot{m}_{air} + \dot{m}_{fuel})V_{out} - \dot{m}_{air}V_{in} + (P_{out} - P_a)A_{out} - (P_{in} - P_a)A_{in}$$

Rocket: $T = \dot{m}_{fuel}V_{out} + (P_{out} - P_a)A_{out}$

HW 2:

$$\sum_{\text{reactants}} n_m\left(h_{g,m} + \int_{T_{ref}}^{T_i} c_{p,m}\,dT\right) = \sum_{\text{products}} n_m\left(h_{g,m} + \int_{T_{ref}}^{T_i} c_{p,m}\,dT\right)$$

Molecular mass: C : 12 H : 1 O : 16 N : 14 [g/mol]

Air to fuel : $A/F = \frac{m_{Air}}{m_{Fuel}} = \frac{n_{Air} W_{air}}{n_{Fuel} W_{Fuel}}$ $F/A = 1 \div A/F$

Equivalent ratio: $\Phi = A/F_{stoichiometry} \div A/F_{current\ condition}$

Excess condition: $T_g \downarrow$

HW 3:

Gas constant: $R = c_p \frac{\gamma - 1}{\gamma}$

$$\Gamma = \sqrt{\gamma}\left(\frac{2}{\gamma+1}\right)^{\frac{(2-e)\gamma + e}{2e(\gamma-1)}}$$

Characteristic velocity: $c^* = \frac{\sqrt{RT_o}}{\Gamma}$

Mass flow rate : $\dot{m} = \frac{\rho_o A^*}{c^*}$

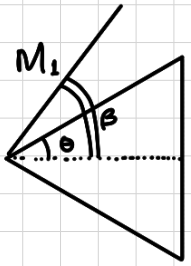
Exhaust velocity : $V_e = \sqrt{2 c_p (T_o - T_e)}$

Thrust coefficient : $C_F = \frac{Thrust}{\rho_o A^*} = \frac{\dot{m} V_{out}}{\rho_o A^*}$

Vacuum condition : $Thrust = \rho_{out} A_{out}\left(\frac{V_{out}^2}{RT_{out}} + 1\right)$

HW 4:

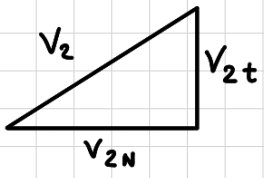
Oblique shock wave:



$M_{1N} = M_1 \sin\beta$

$M_{1N} \rightarrow M_{2N}, \rho_2/\rho_1, T_2/T_1, \rho_{o2}/\rho_{o1}$

$M_2 = \frac{M_{2N}}{\sin(\beta - \theta)}$



$M_2 \rightarrow V_2$

$M_{2N} \rightarrow V_{2N}$

$V_2 = \sqrt{V_{2t}^2 + V_{2N}^2}$

Isentropic flow: ρ_o, T_o stay the same

Polytropic effiency: $\frac{T_{final}}{T_{initial}} = \left(\frac{P_{final}}{P_{initial}}\right)^{\frac{1}{e}\frac{\gamma-1}{\gamma}}$

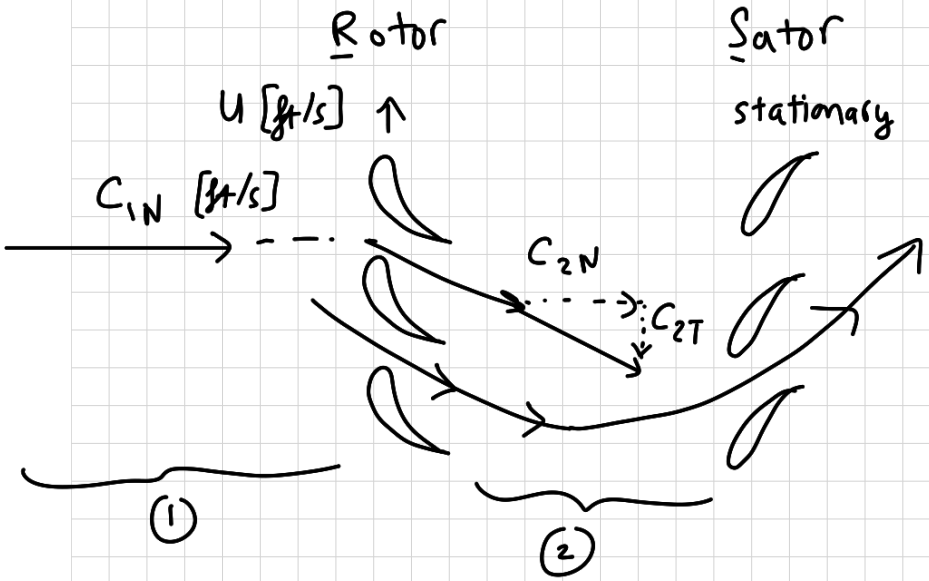
HW5:

Adiabatic effiency: $\eta = \frac{(P_2/P_1)^{\frac{\gamma-1}{\gamma}} - 1}{(T_2/T_1) - 1}$

Compressor power required: $P_r = \dot{m} c_p (T_2 - T_1) =$ Thrust × velocity

Minimum number of stage: $n = \frac{P_2/P_1}{1.6}$ round up

One stage compressor:



$P = \dot{m} U (C_{2T} - C_{1T})$

Entroy change: $\Delta s = c_p \ln\left(\frac{T_2}{T_1}\right) - R \ln\left(\frac{P_2}{P_1}\right)$

Enthalpy drop: $h_1 - h_2 = c_p (T_1 - T_2)$

Enthalpy conserve: $c_p T_1 + \frac{1}{2} V_1^2 = c_p T_2 + \frac{1}{2} V_2^2$

Combustion chamber energy conservation:

$$(\dot{m}_a + \dot{m}_g) c_{p,mixture} T_g - \dot{m}_a c_{p,a} T_i = \eta_b \dot{m}_g Q$$

Propeller power: $P_{prop} = P_{turbine} - P_{compressor}$

HW6:

Mixture temperature: $T = \frac{\dot{m}_1}{\dot{m}_{total}} \times T_1 + \frac{\dot{m}_2}{\dot{m}_{total}} \times T_2$

Thrust: $\text{Thrust} = \dot{m}\sqrt{\frac{2\gamma RT}{\gamma-1}\left[1-\left(\frac{P_{exit}}{P_0}\right)^{\frac{\gamma-1}{\gamma}}\right]}$

Exit velocity: $V_e = \sqrt{2 c_p T_{oi}\left[1-\left(\frac{P_e}{P_{oi}}\right)^{e\,\frac{\gamma-1}{\gamma}}\right]}$

HW7:

Electron mass: $m_e = 9.11 \times 10^{-31}$ [kg]

Boltzman constant: $k = 1.38062 \times 10^{-23}$ [J/K]

Planck constant: $h = 6.62607 \times 10^{-34}$ [Js]

Avogadro constant: $N_A = 6.023 \times 10^{23}$ [1/mol]

Number density: $n = \#\text{ of mole}\ \frac{N_A}{\text{Volum}}$

Electric potential energy: $PE = qV$

Max thrust: $T_{max} = \frac{8}{9}\epsilon_0\left(\frac{V}{L}\right)^2 A$

$= \sqrt{2\frac{m}{q}}\, j_{max}\sqrt{V}\, A$

Mass flow rate: $\dot{m} = \frac{T}{V_e}$

Max current density: $j_{max} = \frac{4}{9}\epsilon_0\sqrt{2\frac{q}{m}}\,\frac{V^{3/2}}{L^2}$

HW8:

Magnetic to electric ratio: $\frac{B}{E} = \frac{1}{\text{Velocity}} \times \frac{\gamma M^2 - 1}{\gamma M^2}$

Current density: $j = \sigma(E - \text{Velocity}\ B)$

Lorentz force: $\vec{F} = \vec{j} \times \vec{B}$

Mixture specific heat: $C_p = Y_1 C_{p,1} + Y_2 C_{p,2}$

Static sensible enthalpy: $h = C_p T$

Table D.I Isentropic Flow Functions for an Ideal Gas with K=1.4

Ma	T/T_o	p/p_o	ρ/ρ_o	A/A^*
0.0000	1.0000	1.0000	1.0000	∞
0.0500	0.9995	0.9983	0.9988	11.5914
0.1000	0.9980	0.9930	0.9950	5.8218
0.1500	0.9955	0.9844	0.9888	3.9103
0.2000	0.9921	0.9725	0.9803	2.9635
0.2500	0.9877	0.9575	0.9694	2.4027
0.3000	0.9823	0.9395	0.9564	2.0351
0.3500	0.9761	0.9188	0.9413	1.7780
0.4000	0.9690	0.8956	0.9243	1.5901
0.4500	0.9611	0.8703	0.9055	1.4487
0.5000	0.9524	0.8430	0.8852	1.3398
0.5500	0.9430	0.8142	0.8634	1.2549
0.6000	0.9328	0.7840	0.8405	1.1882
0.6500	0.9221	0.7528	0.8164	1.1356
0.7000	0.9107	0.7209	0.7916	1.0944
0.7500	0.8989	0.6886	0.7660	1.0624
0.8000	0.8865	0.6560	0.7400	1.0382
0.8500	0.8737	0.6235	0.7136	1.0207
0.9000	0.8606	0.5913	0.6870	1.0089
0.9500	0.8471	0.5595	0.6604	1.0021
1.0000	0.8333	0.5283	0.6339	1.0000
1.0500	0.8193	0.4979	0.6077	1.0020
1.1000	0.8052	0.4684	0.5817	1.0079
1.1500	0.7908	0.4398	0.5562	1.0175
1.2000	0.7764	0.4124	0.5311	1.0304
1.2500	0.7619	0.3861	0.5067	1.0468
1.3000	0.7474	0.3609	0.4829	1.0663
1.3500	0.7329	0.3370	0.4598	1.0890
1.4000	0.7184	0.3142	0.4374	1.1149
1.4500	0.7040	0.2927	0.4158	1.1440
1.5000	0.6897	0.2724	0.3950	1.1762
1.5500	0.6754	0.2533	0.3750	1.2116
1.6000	0.6614	0.2353	0.3557	1.2502
1.6500	0.6475	0.2184	0.3373	1.2922
1.7000	0.6337	0.2026	0.3197	1.3376
1.7500	0.6202	0.1878	0.3029	1.3865
1.8000	0.6068	0.1740	0.2868	1.4390
1.8500	0.5936	0.1612	0.2715	1.4952
1.9000	0.5807	0.1492	0.2570	1.5553
1.9500	0.5680	0.1381	0.2432	1.6193
2.0000	0.5556	0.1278	0.2300	1.6875
2.0500	0.5433	0.1182	0.2176	1.7600
2.1000	0.5313	0.1094	0.2058	1.8369
2.1500	0.5196	0.1011	0.1946	1.9185
2.2000	0.5081	0.0935	0.1841	2.0050
2.2500	0.4969	0.0865	0.1740	2.0964
2.3000	0.4859	0.0800	0.1646	2.1931
2.3500	0.4752	0.0740	0.1556	2.2953
2.4000	0.4647	0.0684	0.1472	2.4031
2.4500	0.4544	0.0633	0.1392	2.5168
2.5000	0.4444	0.0585	0.1317	2.6367
2.5500	0.4347	0.0542	0.1246	2.7630
2.6000	0.4252	0.0501	0.1179	2.8960
2.6500	0.4159	0.0464	0.1115	3.0359
2.7000	0.4068	0.0430	0.1056	3.1830
2.7500	0.3980	0.0398	0.0999	3.3377
2.8000	0.3894	0.0368	0.0946	3.5001
2.8500	0.3810	0.0341	0.0896	3.6707
2.9000	0.3729	0.0317	0.0849	3.8498
2.9500	0.3649	0.0293	0.0804	4.0376
3.0000	0.3571	0.0272	0.0762	4.2346
3.1000	0.3422	0.0234	0.0685	4.6573
3.2000	0.3281	0.0202	0.0617	5.1210
3.3000	0.3147	0.0175	0.0555	5.6286
3.4000	0.3019	0.0151	0.0501	6.1837
3.5000	0.2899	0.0131	0.0452	6.7896
3.6000	0.2784	0.0114	0.0409	7.4501
3.7000	0.2675	0.0099	0.0370	8.1691
3.8000	0.2572	0.0086	0.0335	8.9506
3.9000	0.2474	0.0075	0.0304	9.7990
4.0000	0.2381	0.0066	0.0277	10.7188
4.5000	0.1980	0.0035	0.0174	16.5622
5.0000	0.1667	0.0019	0.0113	25.0000
5.5000	0.1418	0.0011	0.0076	36.8690
6.0000	0.1220	0.0006	0.0052	53.1798
6.5000	0.1058	0.0004	0.0036	75.1343
7.0000	0.0926	0.0002	0.0026	104.1429
7.5000	0.0816	0.0002	0.0019	141.8415
8.0000	0.0725	0.0001	0.0014	190.1094
8.5000	0.0647	0.0001	0.0011	251.0862
9.0000	0.0581	0.0000	0.0008	327.1893
10.0000	0.0476	0.0000	0.0005	535.9375

Table D.S

Normal Shock Functions for an Ideal Gas with $k = 1.4$

Ma_x	Ma_y	p_y/p_x	T_y/T_x	$\rho_y/\rho_x = V_x/V_y$	p_{0y}/p_{0x}	Ma_x	Ma_y	p_y/p_x	T_y/T_x	$\rho_y/\rho_x = V_x/V_y$	p_{0y}/p_{0x}
1.00	1.0000	1.0000	1.0000	1.0000	1.0000	3.05	0.4723	10.6863	2.7383	3.9025	0.3145
1.05	0.9531	1.1196	1.0328	1.0840	0.9999	3.10	0.4695	11.0450	2.7986	3.9466	0.3012
1.10	0.9118	1.2450	1.0649	1.1691	0.9989	3.15	0.4669	11.4096	2.8598	3.9896	0.2885
1.15	0.8750	1.3763	1.0966	1.2550	0.9967	3.20	0.4643	11.7800	2.9220	4.0315	0.2762
1.20	0.8422	1.5133	1.1280	1.3416	0.9928	3.25	0.4619	12.1563	2.9851	4.0723	0.2645
1.25	0.8126	1.6563	1.1594	1.4286	0.9871	3.30	0.4596	12.5383	3.0492	4.1120	0.2533
1.30	0.7860	1.8050	1.1909	1.5157	0.9794	3.35	0.4573	12.9263	3.1142	4.1507	0.2425
1.35	0.7618	1.9596	1.2226	1.6028	0.9697	3.40	0.4552	13.3200	3.1802	4.1884	0.2322
1.40	0.7397	2.1200	1.2547	1.6897	0.9582	3.45	0.4531	13.7196	3.2472	4.2251	0.2224
1.45	0.7196	2.2863	1.2872	1.7761	0.9448	3.50	0.4512	14.1250	3.3151	4.2609	0.2129
1.50	0.7011	2.4583	1.3202	1.8621	0.9298	3.55	0.4492	14.5363	3.3839	4.2957	0.2039
1.55	0.6841	2.6363	1.3538	1.9473	0.9132	3.60	0.4474	14.9533	3.4537	4.3296	0.1953
1.60	0.6684	2.8200	1.3880	2.0317	0.8952	3.65	0.4456	15.3763	3.5245	4.3627	0.1871
1.65	0.6540	3.0096	1.4228	2.1152	0.8760	3.70	0.4439	15.8050	3.5962	4.3949	0.1792
1.70	0.6405	3.2050	1.4583	2.1977	0.8557	3.75	0.4423	16.2396	3.6689	4.4262	0.1717
1.75	0.6281	3.4063	1.4946	2.2791	0.8346	3.80	0.4407	16.6800	3.7426	4.4568	0.1645
1.80	0.6165	3.6133	1.5316	2.3592	0.8127	3.85	0.4392	17.1263	3.8172	4.4866	0.1576
1.85	0.6057	3.8263	1.5693	2.4381	0.7902	3.90	0.4377	17.5783	3.8928	4.5156	0.1510
1.90	0.5956	4.0450	1.6079	2.5157	0.7674	3.95	0.4363	18.0363	3.9694	4.5439	0.1448
1.95	0.5862	4.2696	1.6473	2.5919	0.7442	4.00	0.4350	18.5000	4.0469	4.5714	0.1388
2.00	0.5774	4.5000	1.6875	2.6667	0.7209	4.10	0.4324	19.4450	4.2048	4.6245	0.1276
2.05	0.5691	4.7363	1.7285	2.7400	0.6975	4.20	0.4299	20.4133	4.3666	4.6749	0.1173
2.10	0.5613	4.9783	1.7705	2.8119	0.6742	4.30	0.4277	21.4050	4.5322	4.7229	0.1080
2.15	0.5540	5.2263	1.8132	2.8823	0.6511	4.40	0.4255	22.4200	4.7017	4.7685	0.0995
2.20	0.5471	5.4800	1.8569	2.9512	0.6281	4.50	0.4236	23.4583	4.8751	4.8119	0.0917
2.25	0.5406	5.7396	1.9014	3.0186	0.6055	4.60	0.4217	24.5200	5.0523	4.8532	0.0846
2.30	0.5344	6.0050	1.9468	3.0845	0.5833	4.70	0.4199	25.6050	5.2334	4.8926	0.0781
2.35	0.5286	6.2763	1.9931	3.1490	0.5615	4.80	0.4183	26.7133	5.4184	4.9301	0.0721
2.40	0.5231	6.5533	2.0403	3.2119	0.5401	4.90	0.4167	27.8450	5.6073	4.9659	0.0667
2.45	0.5179	6.8363	2.0885	3.2733	0.5193	5.00	0.4152	29.0000	5.8000	5.0000	0.0617
2.50	0.5130	7.1250	2.1375	3.3333	0.4990	5.50	0.4090	35.1250	6.8218	5.1489	0.0424
2.55	0.5083	7.4196	2.1875	3.3919	0.4793	6.00	0.4042	41.8333	7.9406	5.2683	0.0297
2.60	0.5039	7.7200	2.2383	3.4490	0.4601	6.50	0.4004	49.1250	9.1564	5.3651	0.0211
2.65	0.4996	8.0262	2.2902	3.5047	0.4416	7.00	0.3974	57.0000	10.4694	5.4444	0.0154
2.70	0.4956	8.3383	2.3429	3.5590	0.4236	7.50	0.3949	65.4583	11.8795	5.5102	0.0113
2.75	0.4918	8.6562	2.3966	3.6119	0.4062	8.00	0.3929	74.5000	13.3867	5.5652	0.0085
2.80	0.4882	8.9800	2.4512	3.6636	0.3895	8.50	0.3912	84.1250	14.9911	5.6117	0.0064
2.85	0.4847	9.3096	2.5067	3.7139	0.3733	9.00	0.3898	94.3333	16.6927	5.6512	0.0050
2.90	0.4814	9.6450	2.5632	3.7629	0.3577	9.50	0.3886	105.1250	18.4915	5.6850	0.0039
2.95	0.4782	9.9862	2.6206	3.8106	0.3428	10.00	0.3876	116.5000	20.3875	5.7143	0.0030
3.00	0.4752	10.3333	2.6790	3.8571	0.3283	∞	0.3780	∞	∞	6.0000	0.0000

Table C.1: Weak oblique shock wave angle (β) in degrees for $\gamma = 1.4$

M_1	Flow deflection angle (θ) in degrees																						
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	45
1.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.14	68.71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.16	65.56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.18	63.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.20	61.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.22	59.24	66.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.24	57.60	63.15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.26	56.12	60.93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.28	54.75	59.06	67.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.30	53.47	57.42	63.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.32	52.28	55.95	61.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.34	51.17	54.60	59.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.36	50.11	53.36	57.43	64.29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.38	49.12	52.20	55.96	61.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.40	48.17	51.12	54.63	59.37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.42	47.27	50.10	53.42	57.67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.44	46.42	49.14	52.29	56.19	62.31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.46	45.60	48.23	51.24	54.87	59.98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.48	44.82	47.37	50.25	53.68	58.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.50	44.06	46.54	49.33	52.57	56.68	64.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.52	43.34	45.76	48.45	51.55	55.35	61.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.54	42.65	45.01	47.62	50.59	54.16	59.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.56	41.99	44.29	46.82	49.69	53.06	57.47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.58	41.34	43.59	46.07	48.84	52.05	56.10	63.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.60	40.72	42.93	45.34	48.03	51.12	54.89	60.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.62	40.13	42.29	44.65	47.26	50.23	53.79	58.69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.64	39.55	41.68	43.99	46.53	49.41	52.79	57.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.66	38.99	41.08	43.35	45.84	48.62	51.85	55.93	63.58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.68	38.45	40.51	42.74	45.17	47.88	50.98	54.79	60.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.70	37.93	39.96	42.14	44.53	47.17	50.17	53.77	58.79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.72	37.42	39.42	41.57	43.91	46.49	49.40	52.83	57.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.74	36.93	38.90	41.02	43.32	45.84	48.67	51.96	56.14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.76	36.45	38.40	40.49	42.75	45.22	47.98	51.15	55.06	61.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.78	35.99	37.91	39.98	42.20	44.63	47.32	50.38	54.09	59.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.80	35.54	37.44	39.48	41.67	44.06	46.69	49.66	53.20	57.99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.82	35.10	36.99	39.00	41.16	43.51	46.08	48.98	52.37	56.78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.84	34.68	36.54	38.53	40.67	42.98	45.50	48.33	51.60	55.71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.86	34.26	36.11	38.08	40.19	42.46	44.95	47.71	50.88	54.76	60.91	-	-	-	-	-	-	-	-	-	-	-	-	-
1.88	33.86	35.69	37.64	39.72	41.97	44.41	47.12	50.19	53.90	59.21	-	-	-	-	-	-	-	-	-	-	-	-	-
1.90	33.47	35.28	37.21	39.27	41.49	43.90	46.55	49.54	53.10	57.90	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C.2: Weak oblique shock wave angle (β) in degrees for $\gamma = 1.4$

M_1	Flow deflection angle (θ) in degrees																						
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	45
1.92	33.08	34.88	36.79	38.84	41.03	43.40	46.01	48.93	52.35	56.80	-	-	-	-	-	-	-	-	-	-	-	-	-
1.94	32.71	34.49	36.39	38.41	40.58	42.92	45.48	48.34	51.65	55.83	-	-	-	-	-	-	-	-	-	-	-	-	-
1.96	32.35	34.12	36.00	38.00	40.14	42.46	44.98	47.78	51.00	54.96	61.49	-	-	-	-	-	-	-	-	-	-	-	-
1.98	31.99	33.75	35.61	37.60	39.72	42.01	44.50	47.25	50.37	54.16	59.74	-	-	-	-	-	-	-	-	-	-	-	-
2.00	31.65	33.39	35.24	37.21	39.31	41.58	44.03	46.73	49.79	53.42	58.46	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.02	31.31	33.04	34.88	36.83	38.92	41.15	43.58	46.24	49.22	52.74	57.39	-	-	-	-	-	-	-	-	-	-	-	-
2.04	30.98	32.70	34.52	36.46	38.53	40.75	43.14	45.76	48.69	52.09	56.46	-	-	-	-	-	-	-	-	-	-	-	-
2.06	30.66	32.37	34.18	36.10	38.15	40.35	42.72	45.30	48.17	51.49	55.63	-	-	-	-	-	-	-	-	-	-	-	-
2.08	30.34	32.04	33.84	35.75	37.79	39.97	42.31	44.86	47.68	50.91	54.87	61.28	-	-	-	-	-	-	-	-	-	-	-
2.10	30.03	31.72	33.51	35.41	37.43	39.59	41.91	44.43	47.21	50.36	54.17	59.77	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.12	29.73	31.41	33.19	35.08	37.09	39.23	41.53	44.02	46.75	49.84	53.52	58.62	-	-	-	-	-	-	-	-	-	-	-
2.14	29.44	31.11	32.88	34.76	36.75	38.87	41.15	43.62	46.32	49.35	52.91	57.65	-	-	-	-	-	-	-	-	-	-	-
2.16	29.15	30.81	32.57	34.44	36.42	38.53	40.79	43.23	45.89	48.87	52.34	56.81	-	-	-	-	-	-	-	-	-	-	-
2.18	28.87	30.52	32.27	34.13	36.10	38.20	40.44	42.85	45.49	48.41	51.79	56.05	-	-	-	-	-	-	-	-	-	-	-
2.20	28.59	30.24	31.98	33.83	35.79	37.87	40.09	42.49	45.09	47.98	51.28	55.36	62.70	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.22	28.32	29.96	31.69	33.53	35.48	37.55	39.76	42.14	44.71	47.55	50.79	54.72	60.85	-	-	-	-	-	-	-	-	-	-
2.24	28.06	29.69	31.42	33.24	35.18	37.24	39.44	41.79	44.34	47.15	50.32	54.12	59.63	-	-	-	-	-	-	-	-	-	-
2.26	27.80	29.42	31.14	32.96	34.89	36.94	39.12	41.46	43.98	46.75	49.87	53.56	58.65	-	-	-	-	-	-	-	-	-	-
2.28	27.54	29.16	30.87	32.69	34.60	36.64	38.81	41.13	43.64	46.37	49.44	53.03	57.82	-	-	-	-	-	-	-	-	-	-
2.30	27.29	28.91	30.61	32.42	34.33	36.35	38.51	40.82	43.30	46.01	49.03	52.54	57.08	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.32	27.05	28.66	30.35	32.15	34.05	36.07	38.22	40.51	42.97	45.65	48.63	52.06	56.41	-	-	-	-	-	-	-	-	-	-
2.34	26.81	28.41	30.10	31.89	33.79	35.80	37.93	40.21	42.65	45.31	48.25	51.61	55.79	-	-	-	-	-	-	-	-	-	-
2.36	26.58	28.17	29.86	31.64	33.53	35.53	37.65	39.91	42.34	44.97	47.88	51.18	55.22	61.97	-	-	-	-	-	-	-	-	-
2.38	26.35	27.93	29.61	31.39	33.27	35.26	37.38	39.63	42.04	44.65	47.52	50.77	54.69	60.65	-	-	-	-	-	-	-	-	-
2.40	26.12	27.70	29.38	31.15	33.02	35.01	37.11	39.35	41.75	44.34	47.17	50.37	54.18	59.66	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.42	25.90	27.48	29.14	30.91	32.78	34.76	36.85	39.08	41.46	44.03	46.84	49.99	53.71	58.83	-	-	-	-	-	-	-	-	-
2.44	25.68	27.25	28.92	30.68	32.54	34.51	36.60	38.82	41.18	43.73	46.52	49.62	53.26	58.11	-	-	-	-	-	-	-	-	-
2.46	25.47	27.03	28.69	30.45	32.31	34.27	36.35	38.56	40.91	43.45	46.20	49.27	52.83	57.47	-	-	-	-	-	-	-	-	-
2.48	25.26	26.82	28.47	30.23	32.08	34.03	36.10	38.30	40.65	43.16	45.90	48.93	52.43	56.88	-	-	-	-	-	-	-	-	-
2.50	25.05	26.61	28.26	30.01	31.85	33.80	35.87	38.06	40.39	42.89	45.60	48.60	52.04	56.33	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.52	24.85	26.40	28.05	29.79	31.63	33.58	35.63	37.82	40.14	42.62	45.31	48.28	51.66	55.83	64.27	-	-	-	-	-	-	-	-
2.54	24.65	26.20	27.84	29.58	31.41	33.35	35.41	37.58	39.89	42.36	45.04	47.97	51.30	55.36	62.05	-	-	-	-	-	-	-	-
2.56	24.45	26.00	27.64	29.37	31.20	33.14	35.18	37.35	39.65	42.11	44.76	47.67	50.96	54.91	60.94	-	-	-	-	-	-	-	-
2.58	24.26	25.80	27.44	29.17	30.99	32.92	34.96	37.12	39.41	41.86	44.50	47.38	50.63	54.49	60.08	-	-	-	-	-	-	-	-
2.60	24.07	25.61	27.24	28.97	30.79	32.71	34.75	36.90	39.19	41.62	44.24	47.10	50.31	54.09	59.35	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.62	23.89	25.42	27.05	28.77	30.59	32.51	34.54	36.68	38.96	41.39	43.99	46.83	50.00	53.71	58.72	-	-	-	-	-	-	-	-
2.64	23.70	25.24	26.86	28.58	30.39	32.31	34.33	36.47	38.74	41.16	43.75	46.56	49.70	53.34	58.14	-	-	-	-	-	-	-	-
2.66	23.52	25.05	26.67	28.39	30.20	32.11	34.13	36.26	38.53	40.93	43.51	46.31	49.41	52.99	57.62	-	-	-	-	-	-	-	-
2.68	23.35	24.87	26.49	28.20	30.01	31.92	33.93	36.06	38.32	40.71	43.28	46.05	49.12	52.66	57.14	-	-	-	-	-	-	-	-
2.70	23.17	24.70	26.31	28.02	29.82	31.73	33.74	35.86	38.11	40.50	43.05	45.81	48.85	52.33	56.69	-	-	-	-	-	-	-	-

Table C.3: Weak oblique shock wave angle (β) in degrees for γ = 1.4

M_1	Flow deflection angle (θ) in degrees																						
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	45
2.72	23.00	24.52	26.13	27.84	29.64	31.54	33.55	35.67	37.91	40.29	42.83	45.57	48.59	52.02	56.26	-	-	-	-	-	-	-	-
2.74	22.83	24.35	25.96	27.66	29.46	31.36	33.36	35.48	37.71	40.08	42.61	45.34	48.33	51.72	55.87	63.25	-	-	-	-	-	-	-
2.76	22.67	24.18	25.79	27.49	29.28	31.18	33.18	35.29	37.52	39.88	42.40	45.11	48.08	51.44	55.49	62.00	-	-	-	-	-	-	-
2.78	22.50	24.02	25.62	27.32	29.11	31.00	33.00	35.10	37.33	39.68	42.19	44.89	47.84	51.16	55.13	61.14	-	-	-	-	-	-	-
2.80	22.34	23.85	25.45	27.15	28.94	30.83	32.82	34.92	37.14	39.49	41.99	44.68	47.60	50.89	54.79	60.43	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.82	22.19	23.69	25.29	26.98	28.77	30.66	32.65	34.75	36.96	39.30	41.79	44.47	47.38	50.62	54.46	59.83	-	-	-	-	-	-	-
2.84	22.03	23.54	25.13	26.82	28.61	30.49	32.48	34.57	36.78	39.12	41.60	44.26	47.15	50.37	54.14	59.29	-	-	-	-	-	-	-
2.86	21.88	23.38	24.97	26.66	28.45	30.33	32.31	34.40	36.60	38.94	41.41	44.06	46.93	50.13	53.84	58.80	-	-	-	-	-	-	-
2.88	21.73	23.23	24.82	26.50	28.29	30.17	32.15	34.23	36.43	38.76	41.23	43.86	46.72	49.89	53.55	58.35	-	-	-	-	-	-	-
2.90	21.58	23.08	24.67	26.35	28.13	30.01	31.99	34.07	36.26	38.58	41.04	43.67	46.51	49.65	53.27	57.93	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.92	21.43	22.93	24.52	26.20	27.98	29.85	31.83	33.91	36.10	38.41	40.87	43.48	46.31	49.43	53.00	57.54	-	-	-	-	-	-	-
2.94	21.29	22.78	24.37	26.05	27.82	29.70	31.67	33.75	35.94	38.25	40.69	43.30	46.12	49.21	52.74	57.17	-	-	-	-	-	-	-
2.96	21.15	22.64	24.22	25.90	27.67	29.55	31.52	33.59	35.78	38.08	40.52	43.12	45.92	49.00	52.49	56.83	-	-	-	-	-	-	-
2.98	21.00	22.49	24.08	25.75	27.53	29.40	31.37	33.44	35.62	37.92	40.36	42.95	45.73	48.79	52.25	56.50	-	-	-	-	-	-	-
3.00	20.87	22.35	23.94	25.61	27.38	29.25	31.22	33.29	35.47	37.76	40.19	42.78	45.55	48.59	52.01	56.18	63.67	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.02	20.73	22.22	23.80	25.47	27.24	29.11	31.07	33.14	35.32	37.61	40.03	42.61	45.37	48.39	51.79	55.88	62.58	-	-	-	-	-	-
3.04	20.60	22.08	23.66	25.33	27.10	28.97	30.93	33.00	35.17	37.46	39.87	42.44	45.20	48.20	51.56	55.60	61.83	-	-	-	-	-	-
3.06	20.46	21.95	23.52	25.19	26.96	28.83	30.79	32.85	35.02	37.31	39.72	42.28	45.02	48.01	51.35	55.32	61.21	-	-	-	-	-	-
3.08	20.33	21.81	23.39	25.06	26.83	28.69	30.65	32.71	34.88	37.16	39.57	42.12	44.86	47.83	51.14	55.06	60.68	-	-	-	-	-	-
3.10	20.20	21.68	23.26	24.93	26.69	28.55	30.51	32.57	34.74	37.02	39.42	41.97	44.69	47.65	50.93	54.80	60.21	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.12	20.08	21.56	23.13	24.80	26.56	28.42	30.38	32.44	34.60	36.88	39.27	41.82	44.53	47.47	50.74	54.55	59.78	-	-	-	-	-	-
3.14	19.95	21.43	23.00	24.67	26.43	28.29	30.25	32.30	34.46	36.74	39.13	41.67	44.37	47.30	50.54	54.32	59.38	-	-	-	-	-	-
3.16	19.83	21.30	22.87	24.54	26.30	28.16	30.12	32.17	34.33	36.60	38.99	41.52	44.22	47.13	50.36	54.09	59.02	-	-	-	-	-	-
3.18	19.71	21.18	22.75	24.42	26.18	28.03	29.99	32.04	34.20	36.47	38.85	41.38	44.07	46.97	50.17	53.87	58.67	-	-	-	-	-	-
3.20	19.59	21.06	22.63	24.29	26.05	27.91	29.86	31.92	34.07	36.34	38.72	41.24	43.92	46.81	49.99	53.65	58.35	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.22	19.47	20.94	22.51	24.17	25.93	27.79	29.74	31.79	33.94	36.21	38.59	41.10	43.77	46.65	49.82	53.44	58.05	-	-	-	-	-	-
3.24	19.35	20.82	22.39	24.05	25.81	27.66	29.62	31.67	33.82	36.08	38.46	40.96	43.63	46.50	49.65	53.24	57.76	-	-	-	-	-	-
3.26	19.24	20.70	22.27	23.93	25.69	27.54	29.50	31.55	33.70	35.95	38.33	40.83	43.49	46.35	49.48	53.04	57.48	-	-	-	-	-	-
3.28	19.12	20.59	22.15	23.81	25.57	27.43	29.38	31.43	33.58	35.83	38.20	40.70	43.36	46.21	49.32	52.85	57.22	-	-	-	-	-	-
3.30	19.01	20.48	22.04	23.70	25.46	27.31	29.26	31.31	33.46	35.71	38.08	40.57	43.22	46.06	49.16	52.67	56.96	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.32	18.90	20.36	21.93	23.59	25.34	27.20	29.15	31.19	33.34	35.59	37.96	40.45	43.09	45.92	49.01	52.49	56.72	-	-	-	-	-	-
3.34	18.79	20.25	21.81	23.47	25.23	27.08	29.03	31.08	33.22	35.47	37.84	40.32	42.96	45.78	48.86	52.31	56.49	63.82	-	-	-	-	-
3.36	18.68	20.14	21.70	23.36	25.12	26.97	28.92	30.97	33.11	35.36	37.72	40.20	42.83	45.65	48.71	52.14	56.26	63.02	-	-	-	-	-
3.38	18.57	20.03	21.60	23.25	25.01	26.86	28.81	30.86	33.00	35.25	37.60	40.08	42.71	45.52	48.56	51.97	56.05	62.42	-	-	-	-	-
3.40	18.47	19.93	21.49	23.15	24.90	26.75	28.70	30.75	32.89	35.13	37.49	39.97	42.59	45.39	48.42	51.81	55.84	61.91	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.42	18.36	19.82	21.38	23.04	24.80	26.65	28.60	30.64	32.78	35.02	37.38	39.85	42.47	45.26	48.28	51.65	55.64	61.48	-	-	-	-	-
3.44	18.26	19.72	21.28	22.94	24.69	26.54	28.49	30.53	32.67	34.92	37.27	39.74	42.35	45.13	48.15	51.50	55.44	61.09	-	-	-	-	-
3.46	18.16	19.62	21.17	22.83	24.59	26.44	28.39	30.43	32.57	34.81	37.16	39.63	42.23	45.01	48.01	51.34	55.25	60.73	-	-	-	-	-
3.48	18.06	19.52	21.07	22.73	24.48	26.34	28.28	30.33	32.47	34.71	37.05	39.52	42.12	44.89	47.88	51.20	55.07	60.40	-	-	-	-	-
3.50	17.96	19.42	20.97	22.63	24.38	26.24	28.18	30.22	32.36	34.60	36.95	39.41	42.01	44.77	47.76	51.05	54.89	60.09	-	-	-	-	-

Table C.4: Weak oblique shock wave angle (β) in degrees for γ = 1.4

M_1	Flow deflection angle (θ) in degrees																						
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	45
3.52	17.86	19.32	20.87	22.53	24.28	26.14	28.08	30.12	32.26	34.50	36.84	39.30	41.90	44.66	47.63	50.91	54.71	59.80	-	-	-	-	-
3.54	17.76	19.22	20.77	22.43	24.19	26.04	27.98	30.03	32.16	34.40	36.74	39.20	41.79	44.54	47.51	50.77	54.55	59.53	-	-	-	-	-
3.56	17.67	19.12	20.68	22.33	24.09	25.94	27.89	29.93	32.07	34.30	36.64	39.10	41.69	44.43	47.39	50.64	54.38	59.27	-	-	-	-	-
3.58	17.57	19.03	20.58	22.24	23.99	25.85	27.79	29.83	31.97	34.21	36.54	39.00	41.58	44.32	47.27	50.51	54.22	59.03	-	-	-	-	-
3.60	17.48	18.93	20.49	22.14	23.90	25.75	27.70	29.74	31.88	34.11	36.45	38.90	41.48	44.21	47.15	50.38	54.07	58.79	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.62	17.39	18.84	20.39	22.05	23.81	25.66	27.60	29.65	31.78	34.02	36.35	38.80	41.38	44.11	47.04	50.25	53.91	58.57	-	-	-	-	-
3.64	17.29	18.75	20.30	21.96	23.71	25.57	27.51	29.55	31.69	33.92	36.26	38.70	41.28	44.01	46.93	50.13	53.77	58.36	-	-	-	-	-
3.66	17.20	18.66	20.21	21.87	23.62	25.47	27.42	29.46	31.60	33.83	36.17	38.61	41.18	43.90	46.82	50.00	53.62	58.15	-	-	-	-	-
3.68	17.12	18.57	20.12	21.78	23.53	25.39	27.33	29.38	31.51	33.74	36.07	38.52	41.09	43.80	46.71	49.88	53.48	57.95	-	-	-	-	-
3.70	17.03	18.48	20.03	21.69	23.44	25.30	27.25	29.29	31.42	33.65	35.99	38.43	40.99	43.70	46.61	49.77	53.34	57.76	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.72	16.94	18.39	19.94	21.60	23.36	25.21	27.16	29.20	31.34	33.57	35.90	38.34	40.90	43.61	46.50	49.65	53.21	57.57	-	-	-	-	-
3.74	16.85	18.30	19.86	21.51	23.27	25.12	27.07	29.11	31.25	33.48	35.81	38.25	40.81	43.51	46.40	49.54	53.08	57.40	-	-	-	-	-
3.76	16.77	18.22	19.77	21.43	23.18	25.04	26.99	29.03	31.17	33.40	35.72	38.16	40.72	43.42	46.30	49.43	52.95	57.22	-	-	-	-	-
3.78	16.68	18.13	19.69	21.34	23.10	24.95	26.90	28.95	31.08	33.31	35.64	38.07	40.63	43.33	46.20	49.32	52.82	57.06	65.14	-	-	-	-
3.80	16.60	18.05	19.60	21.26	23.02	24.87	26.82	28.86	31.00	33.23	35.56	37.99	40.54	43.23	46.10	49.22	52.70	56.89	64.19	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.82	16.52	17.97	19.52	21.18	22.93	24.79	26.74	28.78	30.92	33.15	35.47	37.91	40.46	43.15	46.01	49.11	52.58	56.74	63.61	-	-	-	-
3.84	16.44	17.88	19.44	21.09	22.85	24.71	26.66	28.70	30.84	33.07	35.39	37.82	40.37	43.06	45.92	49.01	52.46	56.58	63.14	-	-	-	-
3.86	16.35	17.80	19.36	21.01	22.77	24.63	26.58	28.62	30.76	32.99	35.31	37.74	40.29	42.97	45.83	48.91	52.35	56.43	62.75	-	-	-	-
3.88	16.27	17.72	19.28	20.93	22.69	24.55	26.50	28.55	30.68	32.91	35.23	37.66	40.21	42.89	45.73	48.81	52.24	56.29	62.40	-	-	-	-
3.90	16.20	17.64	19.20	20.85	22.61	24.47	26.42	28.47	30.61	32.83	35.16	37.58	40.13	42.80	45.65	48.72	52.13	56.15	62.09	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.92	16.12	17.56	19.12	20.78	22.54	24.39	26.35	28.39	30.53	32.76	35.08	37.51	40.05	42.72	45.56	48.62	52.02	56.01	61.80	-	-	-	-
3.94	16.04	17.49	19.04	20.70	22.46	24.32	26.27	28.32	30.45	32.68	35.01	37.43	39.97	42.64	45.47	48.53	51.91	55.88	61.53	-	-	-	-
3.96	15.96	17.41	18.96	20.62	22.38	24.24	26.20	28.24	30.38	32.61	34.93	37.35	39.89	42.56	45.39	48.44	51.81	55.75	61.28	-	-	-	-
3.98	15.89	17.33	18.89	20.55	22.31	24.17	26.12	28.17	30.31	32.54	34.86	37.28	39.81	42.48	45.31	48.35	51.71	55.62	61.05	-	-	-	-
4.00	15.81	17.26	18.81	20.47	22.23	24.09	26.05	28.10	30.24	32.46	34.79	37.21	39.74	42.40	45.22	48.26	51.61	55.50	60.83	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.02	15.74	17.18	18.74	20.40	22.16	24.02	25.98	28.03	30.16	32.39	34.71	37.14	39.67	42.33	45.14	48.17	51.51	55.37	60.62	-	-	-	-
4.04	15.66	17.11	18.66	20.32	22.09	23.95	25.91	27.96	30.09	32.32	34.64	37.06	39.59	42.25	45.06	48.09	51.41	55.26	60.42	-	-	-	-
4.06	15.59	17.04	18.59	20.25	22.02	23.88	25.84	27.89	30.03	32.25	34.57	36.99	39.52	42.18	44.99	48.00	51.32	55.14	60.22	-	-	-	-
4.08	15.52	16.96	18.52	20.18	21.95	23.81	25.77	27.82	29.96	32.19	34.51	36.92	39.45	42.10	44.91	47.92	51.22	55.03	60.04	-	-	-	-
4.10	15.45	16.89	18.45	20.11	21.88	23.74	25.70	27.75	29.89	32.12	34.44	36.86	39.38	42.03	44.83	47.84	51.13	54.92	59.86	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.12	15.38	16.82	18.38	20.04	21.81	23.67	25.63	27.68	29.82	32.05	34.37	36.79	39.31	41.96	44.76	47.76	51.04	54.81	59.70	-	-	-	-
4.14	15.31	16.75	18.31	19.97	21.74	23.60	25.56	27.62	29.76	31.99	34.31	36.72	39.25	41.89	44.69	47.68	50.95	54.70	59.53	-	-	-	-
4.16	15.24	16.68	18.24	19.90	21.67	23.54	25.50	27.55	29.69	31.92	34.24	36.66	39.18	41.82	44.61	47.60	50.87	54.60	59.37	-	-	-	-
4.18	15.17	16.61	18.17	19.83	21.60	23.47	25.43	27.49	29.63	31.86	34.18	36.59	39.11	41.75	44.54	47.53	50.78	54.49	59.22	-	-	-	-
4.20	15.10	16.55	18.10	19.77	21.54	23.41	25.37	27.42	29.56	31.79	34.11	36.53	39.05	41.69	44.47	47.45	50.70	54.39	59.07	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.22	15.04	16.48	18.04	19.70	21.47	23.34	25.30	27.36	29.50	31.73	34.05	36.47	38.98	41.62	44.41	47.38	50.62	54.30	58.93	-	-	-	-
4.24	14.97	16.41	17.97	19.64	21.41	23.28	25.24	27.30	29.44	31.67	33.99	36.40	38.92	41.56	44.34	47.30	50.54	54.20	58.79	-	-	-	-
4.26	14.90	16.35	17.90	19.57	21.34	23.21	25.18	27.23	29.38	31.61	33.93	36.34	38.86	41.49	44.27	47.23	50.46	54.11	58.66	-	-	-	-
4.28	14.84	16.28	17.84	19.51	21.28	23.15	25.12	27.17	29.32	31.55	33.87	36.28	38.80	41.43	44.20	47.16	50.38	54.01	58.53	-	-	-	-
4.30	14.77	16.22	17.78	19.44	21.22	23.09	25.06	27.11	29.26	31.49	33.81	36.22	38.74	41.37	44.14	47.09	50.30	53.92	58.40	-	-	-	-