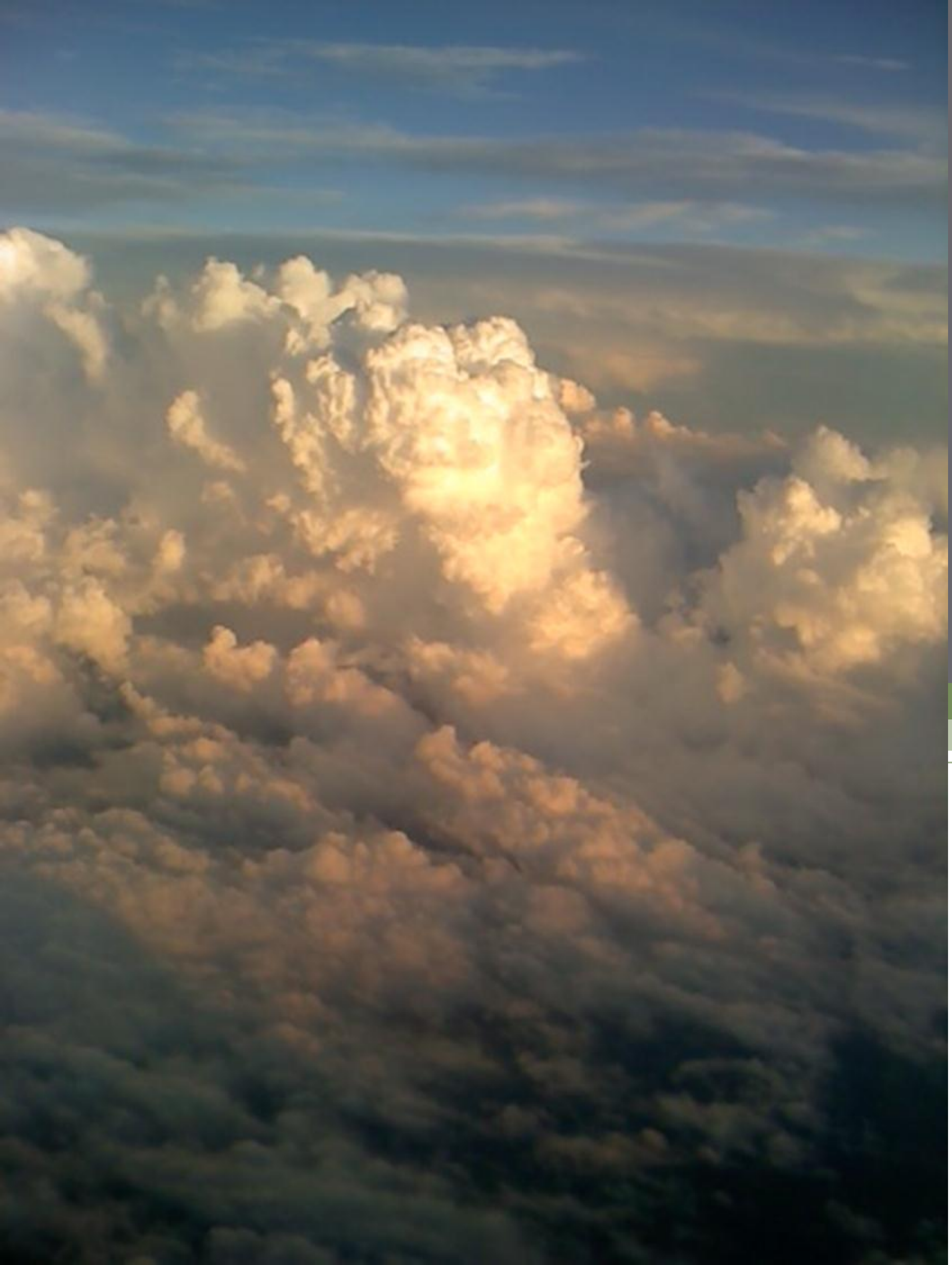


High-Altitude Balloon Atmospheric Database

TAYLOR UNIVERSITY

Presenter: Natalie A. Ramm

Presentation Outline

- Introduction
- Purpose and Use of This Database
- Notes and Future Work
- Conclusion
- Acknowledgements

Introduction

- A Few Uses of High Altitude Balloons
  - Satellite Sensor Testing
  - Student Experiments
- Importance of Balloon Retrieval
  - Guessing Gas Amount
    - Helium Shortage*
    - Potential Waste of Both Time and Money
- Database Information
  - Tolex Balloons from Kaymont Consolidated Industries
  - Helium and Hydrogen Tanks Rented from Indiana Oxygen
  - Currently a Microsoft Excel Workbook

*"Dwindling Stockpile of Helium Causes Concerns by Brad Palmer from The Washington Post, Published May 12, 2012 , Accessed June 15, 2012 from The Washington Post website.

Purpose

- Provide Useful Atmospheric Properties
- Provide Balloon Properties
- Assist in the Estimation of Maximum Balloon Altitude
- Provide Multiple Charts and Graphs for the use in Analyzing Balloon and Atmospheric Properties

Database: Atmospheric Properties

- Speed of Sound
- Dynamic Viscosity
- Kinematic Viscosity
- Mean Air Particle Speed
- Mean Collision Frequency
- Mean Free Path
- Mole Volume

2	Altitude	Temp atmo.	Speed of Sound	Dynamic Viscosity	Kinematic Viscosity	Mean Air Particle Speed	Mean Collision Frequency	Mean Free Path	Mole Volume
3	(km)	(K)	(m/s)	(Ns/m^2)	(m^2/s)	(m/s)	Hz (1/s)	(m)	$m^3/kmol$
4	0	288.15	340.294	1.7894E-05	1.4607E-05	458.945	6.9189E+09	6.6332E-08	23.64
5	1	281.65	336.435	1.7579E-05	1.5813E-05	453.740	6.2070E+09	7.3095E-08	26.06
6	2	275.15	332.532	1.7260E-05	1.7147E-05	448.476	5.5554E+09	8.0728E-08	28.78
7	3	268.66	328.584	1.6938E-05	1.8626E-05	443.151	4.9588E+09	8.9367E-08	31.86
8	4	262.17	324.589	1.6612E-05	2.0275E-05	437.763	4.4141E+09	9.9173E-08	35.35
9	5	255.68	320.545	1.6282E-05	2.2110E-05	432.310	3.9180E+09	1.1034E-07	39.33
10	6	249.19	316.452	1.5949E-05	2.4162E-05	426.789	3.4671E+09	1.2310E-07	43.88
11	7	242.70	312.306	1.5612E-05	2.6461E-05	421.198	3.0584E+09	1.3772E-07	49.09
12	8	236.22	308.105	1.5271E-05	2.9044E-05	415.533	2.6888E+09	1.5454E-07	55.09
13	9	229.73	303.848	1.4926E-05	3.1957E-05	409.791	2.3555E+09	1.7397E-07	62.01
14	10	223.25	299.532	1.4577E-05	3.5251E-05	403.970	2.0558E+09	1.9651E-07	70.05
15	11	216.77	295.154	1.4223E-05	3.8988E-05	398.065	1.7871E+09	2.2274E-07	79.40
16	12	216.65	295.070	1.4216E-05	4.5574E-05	397.952	1.5277E+09	2.6049E-07	92.85
17	13	216.65	295.070	1.4216E-05	5.3325E-05	397.952	1.3056E+09	3.0479E-07	108.65
18	14	216.65	295.070	1.4216E-05	6.2391E-05	397.952	1.1159E+09	3.5662E-07	127.12
19	15	216.65	295.070	1.4216E-05	7.2995E-05	397.952	9.5380E+08	4.1723E-07	148.72
20	16	216.65	295.070	1.4216E-05	8.5397E-05	397.952	8.1528E+08	4.8812E-07	173.99
21	17	216.65	295.070	1.4216E-05	9.9902E-05	397.952	6.9691E+08	5.7102E-07	203.54
22	18	216.65	295.070	1.4216E-05	1.1686E-04	397.952	5.9576E+08	6.6797E-07	238.10
23	19	216.65	295.070	1.4216E-05	1.3670E-04	397.952	5.0931E+08	7.8135E-07	278.52
24	20	216.65	295.070	1.4216E-05	1.5989E-04	397.952	4.3543E+08	9.1393E-07	325.77
25	21	217.58	295.703	1.4267E-05	1.8843E-04	398.806	3.7160E+08	1.0732E-06	382.55
26	22	218.57	296.377	1.4322E-05	2.2201E-04	399.715	3.1733E+08	1.2596E-06	448.99
27	23	219.57	297.049	1.4376E-05	2.6135E-04	400.622	2.7119E+08	1.4772E-06	526.57
28	24	220.56	297.720	1.4430E-05	3.0743E-04	401.526	2.3194E+08	1.7312E-06	617.08
29	25	221.55	298.389	1.4484E-05	3.6135E-04	402.429	1.9852E+08	2.0272E-06	722.60
30	26	222.54	299.056	1.4538E-05	4.2439E-04	403.329	1.7004E+08	2.3720E-06	845.51

Useful Data | Ascent Calculations (Rec. Fill) | Ascent Data Table (Rec. Fill) | Ascent Charts (Rec. Fill) | Ascent Calc. (non-

Listed atmospheric properties are from an online atmospheric properties calculator[3] based on the U.S. Standard Atmosphere 1976[4].

Database: Balloon Properties

- Volume and Diameter
- Coefficient of Drag
- Drag Force
- Free Lift and Lifting Force
- Velocity
- Conductive Heat Transfer
  - See Paper for Nomenclature, Equations, and Derivations used in database

Database: Recommended Fill

- Ascent Calculations (Rec. Fill) Worksheet

	A	B	D	E	F
1	**Mass Options:**			**Positive Direction:**	**Up**
2	**Payload Mass (kg)**	**Balloon Mass (kg)**	**Ballast Mass (kg)**		
3	0.00	0.2	0		
4	0.25	0.3	0.1		
5	0.50	0.6	0.5		
6	1.05	1.0	1		
7	1.50	1.2			
8	2.00	1.5		**Gas Const**	
9	2.50	3.0		m^3 atm $K^{-1}mol^{-1}$	8.206E-05
10	3.00			ft^3 psi °R^{-1} lb-mol^{-1}	10.73159
11	4.00			**Approx # moles in balloon**	
12	**Select Masses:**			mol	222.703
13	Payload Mass	0.00		**Density at STP (metric)**	kg/m^3
14	Balloon Mass	3.00		air (ρa)	1.225
15	Ballast Mass	0.2		He gas (ρ He)	0.1786
16		0.3		H2 gas (ρ H2)	0.08988
17	**Diameter**	0.6 / 1.0		**m_{tot} kg (total mass)**	3.0
18	m	1.2 / 1.5		**Cd**	0.4
19	ft	3.0		**Density at STP (U.S.)**	lb/ft^3
20	**Radius**			air (ρa)	0.0807
21	m	1.06		He gas (ρ He)	0.0111
22	ft	3.477690294		H2 gas (ρ H2)	0.00561
23	**Volume (Vb)**			**Mass He (kg)**	
24	m^3	4.988916155		0.891389839	
25	ft^3	176.1819121		**Mass H_2 (kg)**	
26	**t**			0.448941925	
27	m^2	3.529893506		**Thermal Conductivity**	J/(m*s*K)
28	ft^2	37.99545759		He gas	0.15

Useful Data | **Ascent Calculations (Rec. Fill)** | Ascent Data Table (Rec. Fill) | Ascent Charts (Rec. Fill) | Asc

Database: Recommended Fill

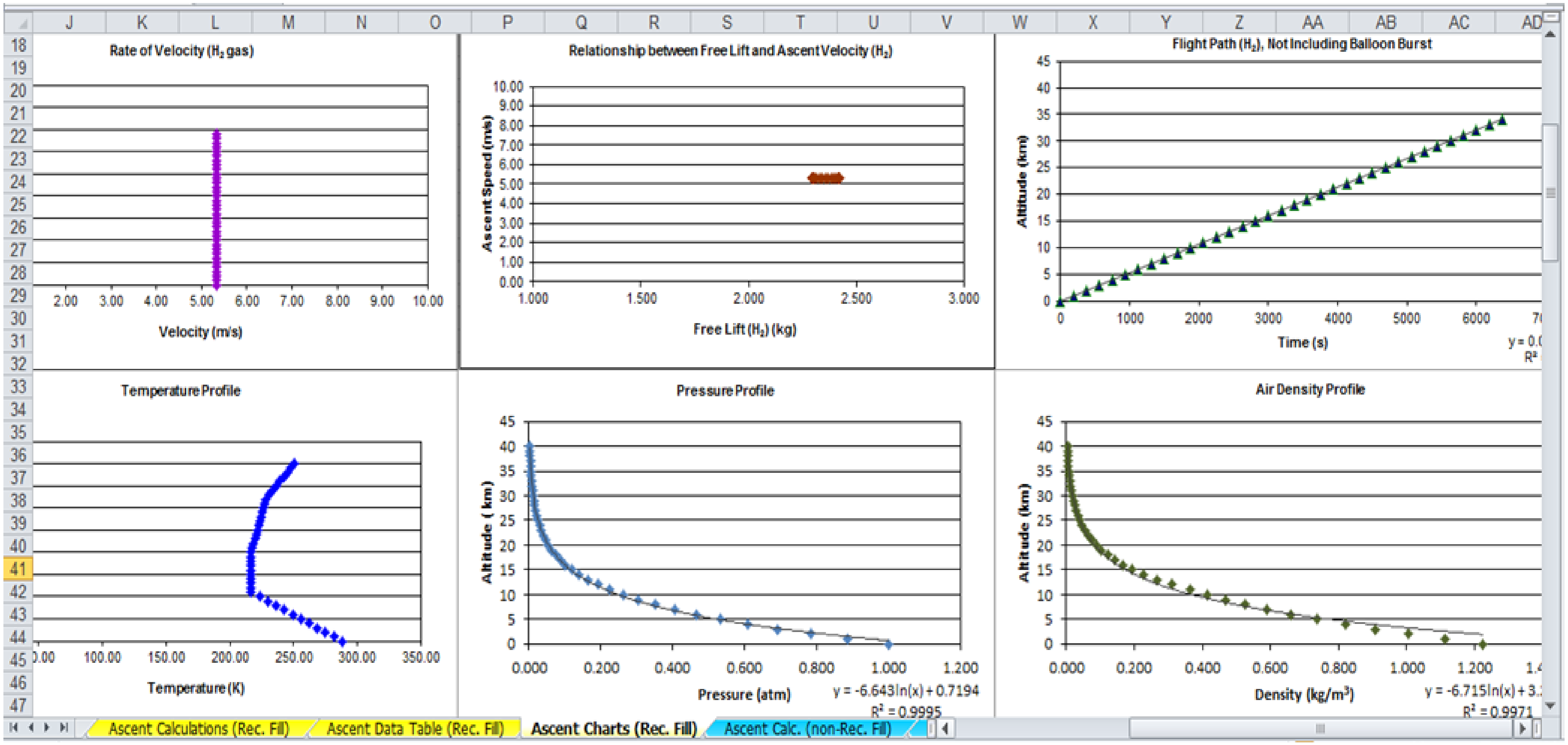
- Ascent Data Table (Rec. Fill) Worksheet

	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Time (He)	Time (H_2)	Temp atmo.	Temp atmo.	Temp gas	Temp gas	ΔT (Ta-Tg)	Pressure	Pressure	ρ of air	Vb	Dia. of bal.	Surface Area	Cross. Sec. Area	C. S. Area/rad.	Conductive Heat Trans
2	Sec. (s)	Sec. (s)	(K)	(°C)	(K)	(°C)	(K, °C)	(atm)	(Psi)	(kg/m^3)	(m^3)	(m)	(m^2)	(m^2)	(m)	(J/s) He
3	0	0	288.15	15.00	286.15	13.00	2.0	1.000	14.696	1.225	1.57	1.44	6.54	1.63	2.27	0.68
4	177	167	281.65	8.50	279.65	6.50	2.0	0.887	13.036	1.112	1.73	1.49	6.97	1.74	2.34	0.70
5	354	333	275.15	2.00	273.15	0.00	2.0	0.785	11.531	1.007	1.91	1.54	7.45	1.86	2.42	0.73
6	530	500	268.66	-4.49	266.66	-6.49	2.0	0.692	10.171	0.909	2.12	1.59	7.97	1.99	2.50	0.75
7	707	667	262.17	-10.98	260.17	-12.98	2.0	0.609	8.944	0.819	2.35	1.65	8.54	2.14	2.59	0.78
8	884	833	255.68	-17.47	253.68	-19.47	2.0	0.533	7.840	0.736	2.61	1.71	9.17	2.29	2.68	0.81
9	1061	1000	249.19	-23.96	246.19	-26.96	3.0	0.466	6.850	0.660	2.90	1.77	9.84	2.46	2.78	1.25
10	1237	1166	242.70	-30.45	238.70	-34.45	4.0	0.406	5.963	0.590	3.23	1.83	10.57	2.64	2.88	1.73
11	1414	1332	236.22	-36.93	231.22	-41.93	5.0	0.352	5.172	0.526	3.61	1.90	11.38	2.84	2.99	2.24
12	1590	1498	229.73	-43.42	223.73	-49.42	6.0	0.304	4.469	0.467	4.04	1.98	12.27	3.07	3.10	2.79
13	1767	1664	223.25	-49.90	216.25	-56.90	7.0	0.262	3.845	0.414	4.54	2.05	13.26	3.32	3.23	3.39
14	1943	1829	216.77	-56.38	208.77	-64.38	8.0	0.224	3.294	0.365	5.12	2.14	14.36	3.59	3.36	4.03
15	2119	1994	216.65	-56.50	207.65	-65.50	9.0	0.191	3.250	0.312	5.96	2.25	15.89	3.97	3.53	4.77
16	2295	2160	216.65	-56.50	206.65	-66.50	10.0	0.164	2.406	0.267	6.94	2.37	17.59	4.40	3.72	5.57
17	2471	2325	216.65	-56.50	205.65	-67.50	11.0	0.140	2.056	0.228	8.08	2.49	19.47	4.87	3.91	6.45
18	2646	2489	216.65	-56.50	204.65	-68.50	12.0	0.120	1.758	0.195	9.40	2.62	21.54	5.39	4.11	7.40
19	2822	2654	216.65	-56.50	204.65	-68.50	12.0	0.102	1.503	0.166	11.00	2.76	23.92	5.98	4.33	7.80
20	2998	2819	216.65	-56.50	204.65	-68.50	12.0	0.087	1.284	0.142	12.87	2.91	26.56	6.64	4.57	8.22
21	3174	2983	216.65	-56.50	204.65	-68.50	12.0	0.075	1.098	0.122	15.05	3.06	29.48	7.37	4.81	8.66
22	3349	3148	216.65	-56.50	204.65	-68.50	12.0	0.064	0.939	0.104	17.61	3.23	32.73	8.18	5.07	9.13
23	3525	3313	216.65	-56.50	204.65	-68.50	12.0	0.055	0.803	0.089	20.59	3.40	36.33	9.08	5.34	9.62
24	3701	3478	217.58	-55.57	205.58	-67.57	12.0	0.047	0.686	0.076	24.19	3.59	40.45	10.11	5.64	10.15
25	3877	3642	218.57	-54.58	206.57	-66.58	12.0	0.040	0.588	0.065	28.40	3.79	45.01	11.25	5.95	10.70
26	4052	3807	219.57	-53.58	207.57	-65.58	12.0	0.034	0.503	0.055	33.32	3.99	50.07	12.52	6.27	11.29
27	4228	3972	220.56	-52.59	208.56	-64.59	12.0	0.029	0.431	0.047	39.05	4.21	55.66	13.92	6.61	11.90
28	4404	4137	221.55	-51.60	209.55	-63.60	12.0	0.025	0.370	0.040	45.74	4.44	61.85	15.46	6.97	12.55
29	4580	4302	222.54	-50.61	210.54	-62.61	12.0	0.022	0.318	0.034	53.53	4.68	68.69	17.17	7.35	13.22
30	4755	4466	223.54	-49.61	211.54	-61.61	12.0	0.019	0.273	0.029	62.61	4.93	76.25	19.06	7.74	13.93

Ascent Data Table (Rec. Fill) | Ascent Charts (Rec. Fill) | Ascent Calc. (non-Rec. Fill) | Ascent Data Tab (non-Rec. Fill)

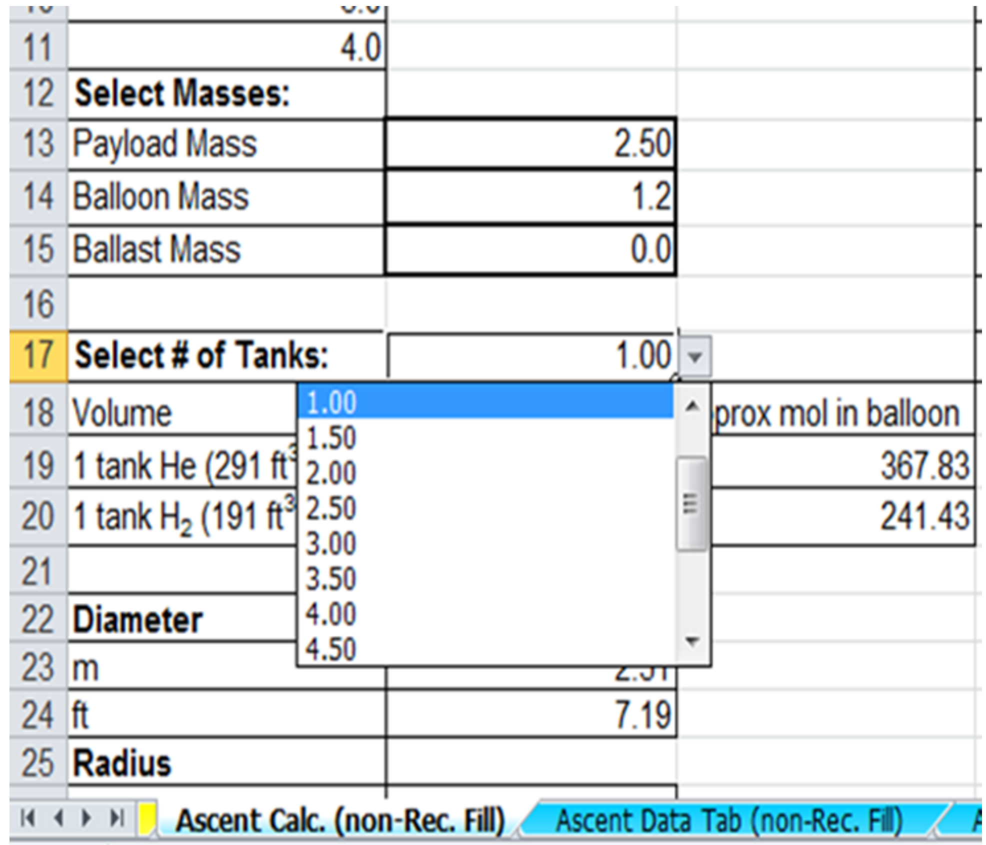
Database: Recommended Fill

- Ascent Charts (Rec. Fill) Worksheet



Database: Non-Recommended Fill

- Ascent Calc. (non-Rec. Fill) Worksheet
  - Input Number of Tanks of Gas Including Partial Tanks
  - Helium Tank Volume: 291 ft^3
  - Hydrogen Tank Volume: 191 ft^3
  - Approximate moles computed from Ideal Gas law



Database: Non-Recommended Fill

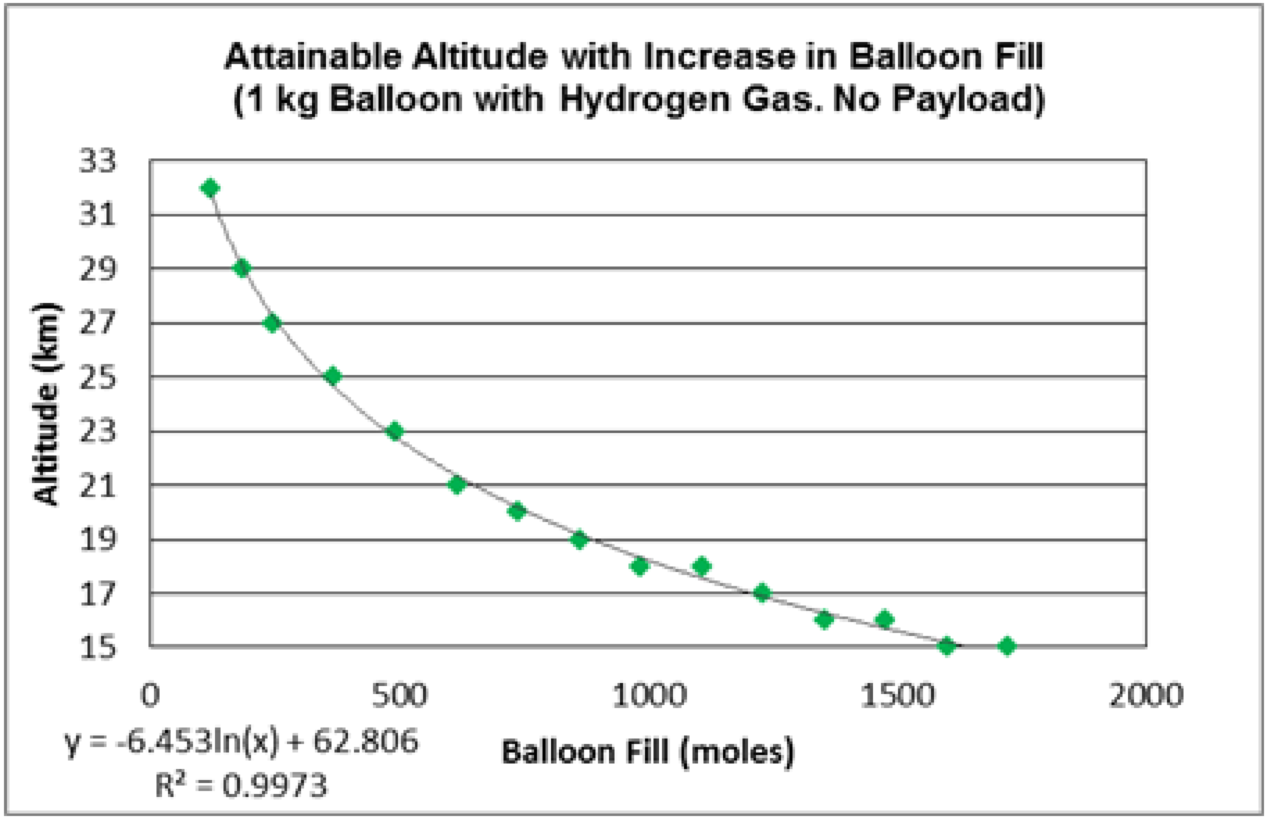
- Ascent Data Table (non-Rec. Fill) Worksheet

	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	
1	Temp atmo.	Temp atmo.	Temp gas	Temp gas	ΔT (Ta-Tg)	Pressure	Pressure	Gas Pressure	Gas Pressure	ρ of air	Vb	Vb	Dia. of bal.	Dia. of bal.	Cross Sec. Area	Cross Sec. Area	Con
2	(K)	(°C)	(K)	(°C)	(K,°C)	(atm)	(Psi)	He atm	H_2 atm	(kg/m^3)	He (m^3)	H_2 (m^3)	He (m)	H_2 (m)	He (m^2)	H_2 (m^2)	(J/s)
3	288.15	15.00	286.15	13.00	2.0	1.000	14.696	1.000	1.524	1.225	8.64	5.67	2.55	2.21	5.09	3.84	
4	281.65	8.50	279.65	6.50	2.0	0.887	13.036	0.887	1.351	1.112	9.52	6.25	2.63	2.28	5.43	4.10	
5	275.15	2.00	273.15	0.00	2.0	0.785	11.531	0.785	1.195	1.007	10.51	6.90	2.72	2.36	5.80	4.38	
6	268.66	-4.49	266.66	-6.49	2.0	0.692	10.171	0.692	1.054	0.909	11.63	7.63	2.81	2.44	6.21	4.69	
7	262.17	-10.98	260.17	-12.98	2.0	0.609	8.944	0.609	0.927	0.819	12.90	8.47	2.91	2.53	6.65	5.02	
8	255.68	-17.47	253.68	-19.47	2.0	0.533	7.840	0.533	0.813	0.736	14.35	9.42	3.02	2.62	7.14	5.39	
9	249.19	-23.96	246.19	-26.96	3.0	0.466	6.850	0.466	0.710	0.660	15.95	10.47	3.12	2.71	7.66	5.78	
10	242.70	-30.45	238.70	-34.45	4.0	0.406	5.963	0.406	0.618	0.590	17.76	11.66	3.24	2.81	8.23	6.22	
11	236.22	-36.93	231.22	-41.93	5.0	0.352	5.172	0.352	0.536	0.526	19.83	13.02	3.36	2.92	8.86	6.69	
12	229.73	-43.42	223.73	-49.42	6.0	0.304	4.469	0.304	0.463	0.467	22.22	14.58	3.49	3.03	9.55	7.22	
13	223.25	-49.90	216.25	-56.90	7.0	0.262	3.845	0.262	0.398	0.414	24.96	16.38	3.63	3.15	10.33	7.80	
14	216.77	-56.38	208.77	-64.38	8.0	0.224	3.294	0.224	0.341	0.365	28.13	18.46	3.77	3.28	11.18	8.45	
15	216.65	-56.50	207.65	-65.50	9.0	0.191	3.250	0.191	0.292	0.312	32.74	21.49	3.97	3.45	12.37	9.34	
16	216.65	-56.50	206.65	-66.50	10.0	0.164	2.406	0.164	0.249	0.267	38.12	25.02	4.18	3.63	13.69	10.34	
17	216.65	-56.50	205.65	-67.50	11.0	0.140	2.056	0.140	0.213	0.228	44.38	29.13	4.39	3.82	15.16	11.45	
18	216.65	-56.50	204.65	-68.50	12.0	0.120	1.758	0.120	0.182	0.195	51.68	33.92	4.62	4.02	16.77	12.67	
19	216.65	-56.50	204.65	-68.50	12.0	0.102	1.503	0.102	0.156	0.166	60.46	39.68	4.87	4.23	18.62	14.07	
20	216.65	-56.50	204.65	-68.50	12.0	0.087	1.284	0.087	0.133	0.142	70.72	46.42	5.13	4.46	20.68	15.62	
21	216.65	-56.50	204.65	-68.50	12.0	0.075	1.098	0.075	0.114	0.122	82.73	54.30	5.41	4.70	22.95	17.34	
22	216.65	-56.50	204.65	-68.50	12.0	0.064	0.939	0.064	0.097	0.104	96.77	63.52	5.70	4.95	25.48	19.25	
23	216.65	-56.50	204.65	-68.50	12.0	0.055	0.803	0.055	0.083	0.089	113.19	74.30	6.00	5.22	28.29	21.37	
24	217.58	-55.57	205.58	-67.57	12.0	0.047	0.686	0.047	0.071	0.076	132.95	87.27	6.33	5.50	31.49	23.79	
25	218.57	-54.58	206.57	-66.58	12.0	0.040	0.588	0.040	0.061	0.065	156.09	102.45	6.68	5.81	35.05	26.47	
26	219.57	-53.58	207.57	-65.58	12.0	0.034	0.503	0.034	0.052	0.055	183.11	120.19	7.05	6.12	38.98	29.44	
27	220.56	-52.59	208.56	-64.59	12.0	0.029	0.431	0.029	0.045	0.047	214.63	140.88	7.43	6.46	43.34	32.73	

Ascent Data Table (Rec. Fill) | Ascent Charts (Rec. Fill) | Ascent Calc. (non-Rec. Fill) | Ascent Data Tab (non-Rec. Fill)

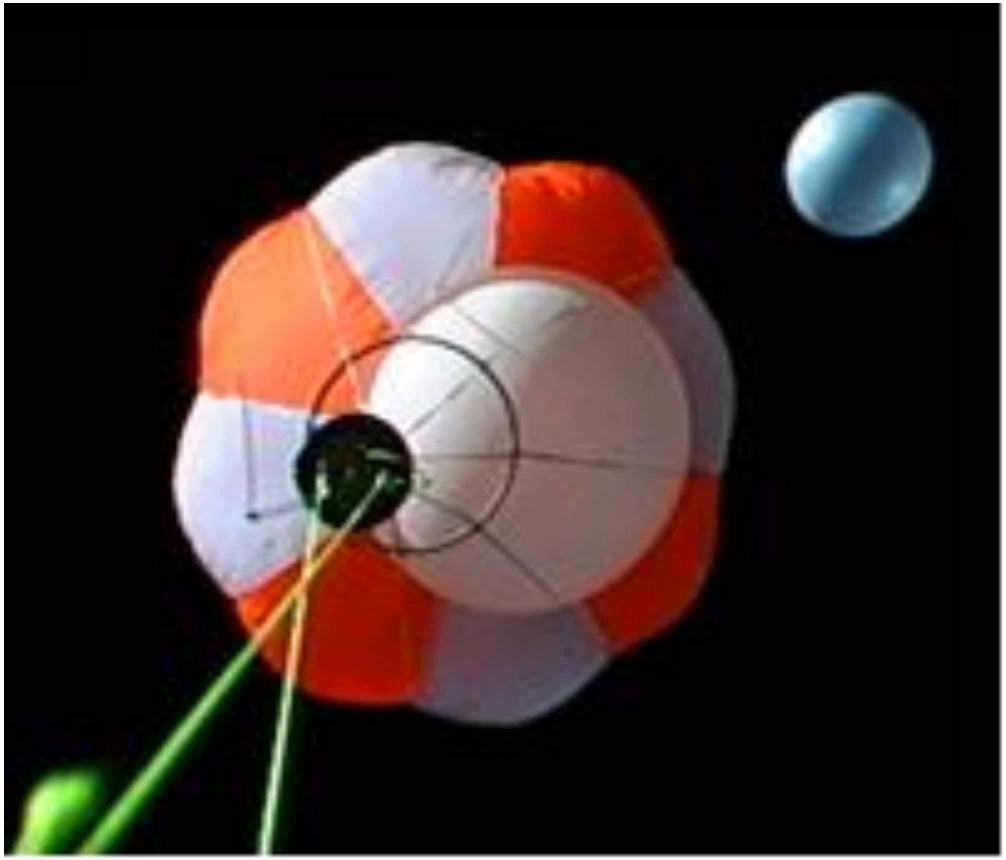
Database: Non-Recommended Fill

- Ascent Charts (non-Rec. Fill) Worksheet



Database: Descent with Small Balloon

- Descent Calculations (SB) Worksheet
  - Why a small balloon?
  - Balloon size options
  - Recommended fill used



Note: Photo credited to reference 4 when the correct reference is 6.

Database: Descent with Small Balloon

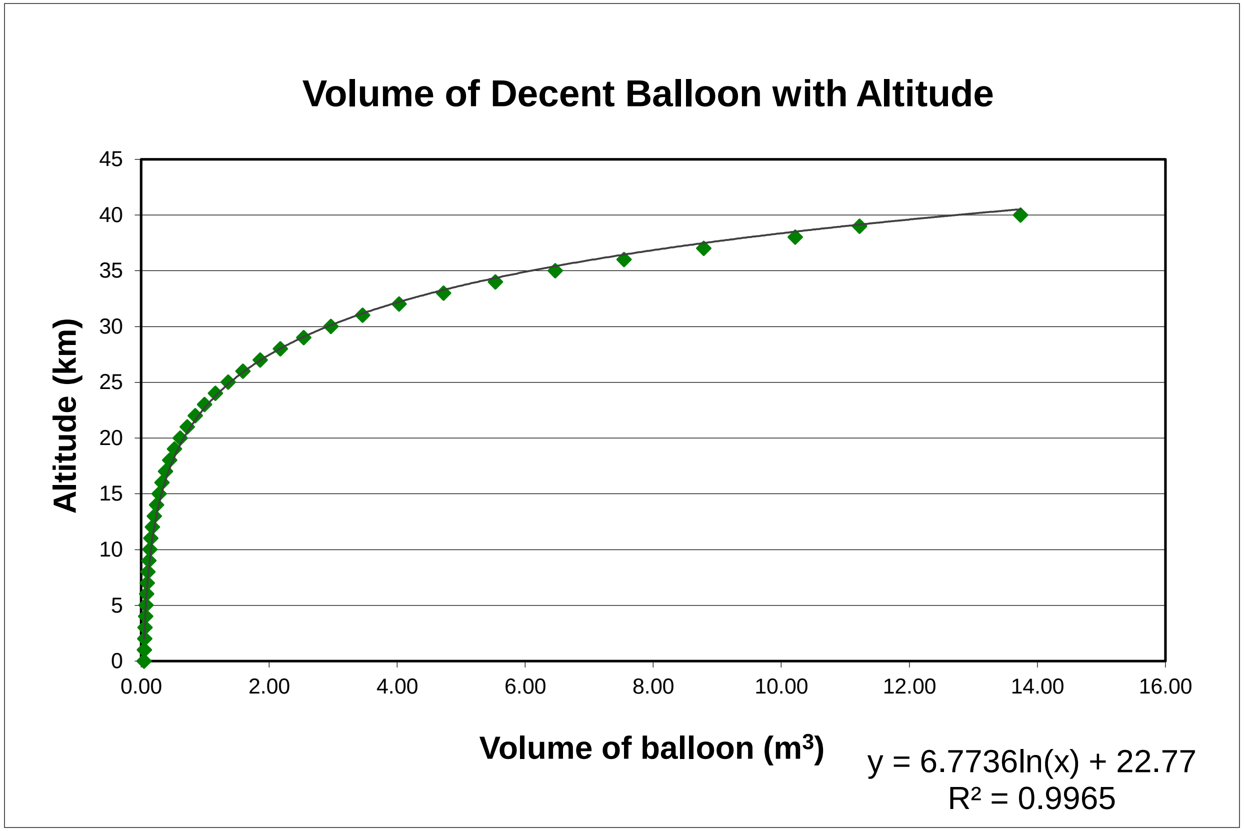
- Descent Data Table (SB) Worksheet

	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	
1	Pressure	Pressure	Gas Pressure	ρ of air	Vb	Dia. of bal.	ρHe in balloon	ρH2 in balloon	V	V	Coef. of Drag	Gravity	Free Lift	Free Lift	Lifting Force	Lifting Force	Mag. Drag F
2	(atm)	(Psi)	(atm)	(kg/m³)	(m³)	(m)	(kg/m³)	(kg/m³)	(He)(m/s)	(H_2)(m/s)	Cd	(m/s²)	He (kg)	H_2 (kg)	(He) (N)	(H_2) (N)	(He) (N)
3	0.003	0.042	0.003	0.004	13.74	Balloon will burst if used w/ rec. fill	0.0006	0.0003	-7.83	-7.79	5.397	9.684	0.047	0.051	0.455	0.493	
4	0.003	0.048	0.003	0.005	11.22	Balloon will burst if used w/ rec. fill	0.0007	0.0004	-7.83	-7.80	5.331	9.687	0.044	0.048	0.426	0.464	
5	0.004	0.055	0.004	0.005	10.22	Balloon will burst if used w/ rec. fill	0.0008	0.0004	-7.83	-7.80	4.889	9.690	0.047	0.051	0.454	0.493	
6	0.004	0.063	0.004	0.006	8.79	Balloon will burst if used w/ rec. fill	0.0009	0.0005	-7.84	-7.81	4.649	9.694	0.047	0.051	0.454	0.492	
7	0.005	0.072	0.005	0.007	7.55	Balloon will burst if used w/ rec. fill	0.0011	0.0005	-7.84	-7.81	4.418	9.697	0.047	0.051	0.454	0.492	
8	0.006	0.083	0.006	0.008	6.47	Balloon will burst if used w/ rec. fill	0.0012	0.0006	-7.84	-7.82	4.195	9.700	0.047	0.051	0.454	0.492	
9	0.007	0.096	0.007	0.010	5.53	Balloon will burst if used w/ rec. fill	0.0014	0.0007	-7.85	-7.82	3.982	9.703	0.047	0.051	0.453	0.492	
10	0.008	0.111	0.008	0.012	4.72	Balloon will burst if used w/ rec. fill	0.0017	0.0008	-7.85	-7.83	3.777	9.706	0.047	0.051	0.453	0.492	
11	0.009	0.129	0.010	0.014	4.03	Balloon will burst if used w/ rec. fill	0.0020	0.0010	-7.85	-7.83	3.582	9.709	0.047	0.051	0.453	0.492	
12	0.010	0.150	0.011	0.016	3.46	Balloon will burst if used w/ rec. fill	0.0023	0.0012	-7.85	-7.83	3.404	9.712	0.047	0.051	0.453	0.492	
13	0.012	0.174	0.013	0.018	2.97	Balloon will burst if used w/ rec. fill	0.0027	0.0014	-7.85	-7.83	3.235	9.715	0.047	0.051	0.453	0.492	
14	0.014	0.202	0.015	0.021	2.54	Balloon will burst if used w/ rec. fill	0.0031	0.0016	-7.85	-7.84	3.073	9.718	0.047	0.051	0.453	0.492	
15	0.016	0.235	0.018	0.025	2.18	Balloon will burst if used w/ rec. fill	0.0037	0.0018	-7.86	-7.84	2.918	9.721	0.047	0.051	0.453	0.492	
16	0.019	0.273	0.021	0.029	1.86	Balloon will burst if used w/ rec. fill	0.0043	0.0022	-7.86	-7.84	2.771	9.724	0.047	0.051	0.453	0.492	
17	0.022	0.318	0.024	0.034	1.59	Balloon will burst if used w/ rec. fill	0.0050	0.0025	-7.86	-7.84	2.630	9.727	0.047	0.051	0.453	0.492	
18	0.025	0.370	0.029	0.040	1.36	Balloon will burst if used w/ rec. fill	0.0059	0.0029	-7.86	-7.84	2.496	9.730	0.047	0.051	0.453	0.492	
19	0.029	0.431	0.034	0.047	1.16	Balloon will burst if used w/ rec. fill	0.0069	0.0035	-7.86	-7.84	2.368	9.733	0.047	0.051	0.453	0.492	
20	0.034	0.503	0.039	0.055	0.99	Balloon will burst if used w/ rec. fill	0.0080	0.0040	-7.86	-7.85	2.246	9.736	0.047	0.051	0.453	0.492	
21	0.040	0.588	0.046	0.065	0.84	Balloon will burst if used w/ rec. fill	0.0094	0.0048	-7.86	-7.85	2.131	9.742	0.047	0.050	0.453	0.492	
22	0.047	0.686	0.054	0.076	0.72	Balloon will burst if used w/ rec. fill	0.0111	0.0056	-7.86	-7.85	2.019	9.742	0.047	0.050	0.453	0.492	
23	0.055	0.803	0.064	0.089	0.61	Balloon will burst if used w/ rec. fill	0.0130	0.0066	-7.86	-7.85	1.914	9.745	0.047	0.050	0.453	0.492	
24	0.064	0.939	0.074	0.104	0.52	Balloon will burst if used w/ rec. fill	0.0152	0.0077	-7.86	-7.85	1.817	9.748	0.047	0.050	0.453	0.492	
25	0.075	1.098	0.087	0.122	0.45	Balloon will burst if used w/ rec. fill	0.0178	0.0090	-7.86	-7.85	1.725	9.751	0.047	0.050	0.454	0.492	
26	0.087	1.284	0.102	0.142	0.38	Balloon will burst if used w/ rec. fill	0.0208	0.0105	-7.86	-7.85	1.638	9.754	0.047	0.050	0.454	0.492	
27	0.102	1.503	0.119	0.166	0.33	Balloon will burst if used w/ rec. fill	0.0244	0.0123	-7.86	-7.85	1.555	9.758	0.047	0.050	0.454	0.492	
28	0.120	1.758	0.139	0.195	0.28	Balloon will burst if used w/ rec. fill	0.0285	0.0143	-7.85	-7.85	1.476	9.761	0.047	0.050	0.454	0.493	
29	0.140	2.056	0.162	0.228	0.24	Balloon will burst if used w/ rec. fill	0.0332	0.0167	-7.82	-7.82	1.409	9.764	0.047	0.051	0.457	0.495	
30	0.164	2.406	0.189	0.267	0.21	Balloon will burst if used w/ rec. fill	0.0386	0.0195	-7.78	-7.78	1.345	9.767	0.047	0.051	0.459	0.498	

Ascent Charts (non-Rec. Fill) | Descent Calculations (SB) | Descent Data Table (SB) | Descent Charts (SB) | Descent C

Database: Descent with Small Balloon

- Descent Charts (SB) Worksheet



Database: Descent with Parachute

- Descent Calculations (Parachute) Worksheet

	A	B	C	D	E
1	**Mass Options:**			**Positive Direction:**	**Up**
2	**Payload Mass (kg)**	**Parachute Mass (kg)**	**Ballast Mass (kg)**	**Parachute Diameter:**	**72 in or 6 ft**
3	0.0	0.10	0		
4	0.5	0.20	0.1		
5	1.0		0.5		
6	1.5		1		
7	2.0				
8	2.5			**Density at STP (metric)**	kg/m^3
9	3.0			air (ρa)	1.225
10	4.0			**m_{tot} kg (total mass)**	2.1
11	**Select Masses:**			**Cd**	1.5
12	Payload Mass	2.00		**Density at STP (U.S.)**	lb/ft^3
13	Parachute Mass	0.10		air (ρa)	1.293
14	Ballast Mass	0.00			
15					
16	**Diameter Para.**				
17	m	1.83			
18	ft	6.00			
19	**Radius Para.**				
20	m	0.9144			
21	ft	3			
22	**Volume (Vp)**				
23	m^3	1.60127995			
24	ft^3	113.0973355			
25	**C.S. Area Para.**				
26	m^2	1.654762398			

Descent Charts (SB) | Descent Calc. (Parachute) | Descent Data Table (Parachute) | Descent Charts (Parachute)

Database: Descent with Parachute

- Descent Data Table (Parachute) Worksheet

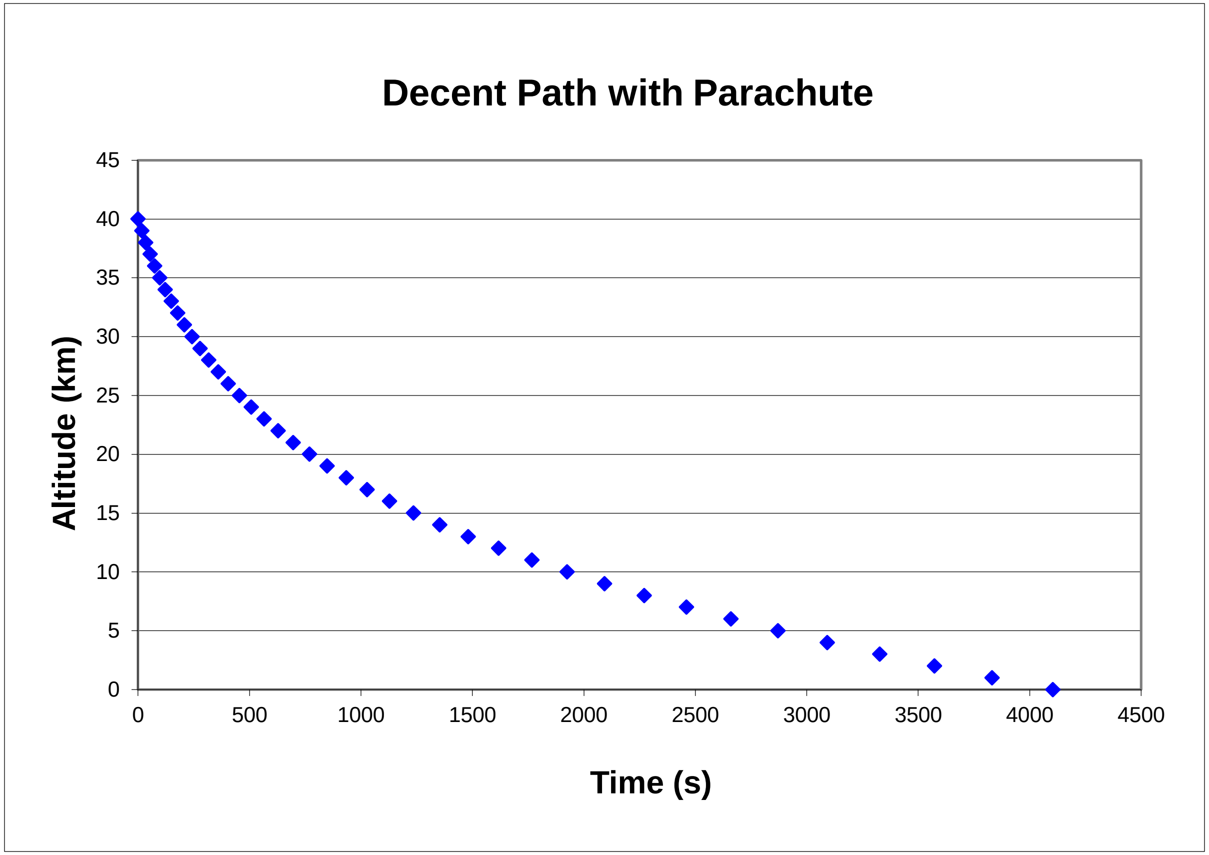
	A	B	C	D	E	F	G	H	I	J	K	L
1	**Altitude**	**Altitude**	**Time**	**Temp. Atmo.**	**Temp. Atmo.**	**Pressure**	**Pressure**	**ρ of air**	**V Down**	**Coef. of Drag**	**Gravity**	**Drag Force w/ m_{tot}**
2	**(km)**	**(ft)**	**(s)**	**(K)**	**(°C)**	**(atm)**	**(Psi)**	**(kg/m³)**	**(m/s)**	**Cd**	**(m/s²)**	**(N)**
3	40	131200	0	250.35	-22.80	0.003	0.042	0.004	64.04	1.50	9.684	20.34
4	39	127920	17	247.58	-25.57	0.003	0.048	0.005	59.52	1.50	9.687	20.34
5	38	124640	35	244.82	-28.33	0.004	0.055	0.005	55.28	1.50	9.690	20.35
6	37	121360	54	242.05	-31.10	0.004	0.063	0.006	51.29	1.50	9.694	20.36
7	36	118080	75	239.28	-33.87	0.005	0.072	0.007	47.55	1.50	9.697	20.36
8	35	114800	98	236.51	-36.64	0.006	0.083	0.008	44.04	1.50	9.700	20.37
9	34	111520	123	233.74	-39.41	0.007	0.096	0.010	40.75	1.50	9.703	20.38
10	33	108240	149	230.97	-42.18	0.008	0.111	0.012	37.67	1.50	9.706	20.38
11	32	104960	178	228.49	-44.66	0.009	0.129	0.014	34.81	1.50	9.709	20.39
12	31	101680	209	227.50	-45.65	0.010	0.150	0.016	32.26	1.50	9.712	20.39
13	30	98400	242	226.51	-46.64	0.012	0.174	0.018	29.88	1.50	9.715	20.40
14	29	95120	279	225.52	-47.63	0.014	0.202	0.021	27.67	1.50	9.718	20.41
15	28	91840	318	224.53	-48.62	0.016	0.235	0.025	25.61	1.50	9.721	20.41
16	27	88560	360	223.54	-49.61	0.019	0.273	0.029	23.70	1.50	9.724	20.42
17	26	85280	405	222.54	-50.61	0.022	0.318	0.034	21.92	1.50	9.727	20.43
18	25	82000	455	221.55	-51.60	0.025	0.370	0.040	20.27	1.50	9.730	20.43
19	24	78720	508	220.56	-52.59	0.029	0.431	0.047	18.73	1.50	9.733	20.44
20	23	75440	566	219.57	-53.58	0.034	0.503	0.055	17.31	1.50	9.736	20.45
21	22	72160	628	218.57	-54.58	0.040	0.588	0.065	15.99	1.50	9.742	20.46
22	21	68880	696	217.58	-55.57	0.047	0.686	0.076	14.76	1.50	9.742	20.46
23	20	65600	770	216.65	-56.50	0.055	0.803	0.089	13.62	1.50	9.745	20.46
24	19	62320	849	216.65	-56.50	0.064	0.939	0.104	12.59	1.50	9.748	20.47
25	18	59040	935	216.65	-56.50	0.075	1.098	0.122	11.65	1.50	9.751	20.48
26	17	55760	1028	216.65	-56.50	0.087	1.284	0.142	10.77	1.50	9.754	20.48
27	16	52480	1128	216.65	-56.50	0.102	1.503	0.166	9.96	1.50	9.758	20.49

	N
1	**Troposphere**
2	temp decrease with altitude increase
3	**Tropopause**
4	temp constant with altitude increase
5	**Upper Stratosphere**
6	temp increase with altitude increase
7	**Additional comment**
8	reletivily un-experimented space

Descent Charts (SB) | Descent Calc. (Parachute) | **Descent Data Table (Parachute)** | Descent Charts (Parachute)

Database: Descent with Parachute

- Descent Charts (Parachute) Worksheet



Additional Notes and Future Work

- Acceleration?
- Coefficient of Drag
- Drag Force, Lifting Force, and Free Lift
- Ideas for Possible Database Additions
- Beta Test
  - Website:
    - http://cse.taylor.edu/~nramm/High_Altitude_Balloon_Databases/

Conclusions

- More Fill
  - Doesn’t Give a Higher Altitude
  - Faster Ascent Rate
- Ending Thoughts

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