Duct flow Formula © John Gwynn 2003		Fluid duct Model > Main rocket diameter				Large dia >Specific conical duct for Badoit																												© John Gwynn All rights reserved 2002. > Small nozzle dia msc		
Conical flow volume equation																																				
For depth x = cm.						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	19,7	20								
x^3						1	8	27	64	125	216	343	512	729	1000	1331	1728	2197	2744	3375	4096	4913	5832	6859	7645,373	8000								
0,022693																																				
x^3 * 0,022693						0,022693	0,181544	0,612711	1,452352	2,836625	4,901688	7,783699	11,618816	16,543197	22,693	30,204383	39,213504	49,856521	62,269592	76,588875	92,950528	111,490709	132,345576	155,651287	173,496449	181,544								
x^2						1	4	9	16	25	36	49	64	81	100	121	144	169	196	225	256	289	324	361	388,09	400								
-1,849856																																				
x^2 * (-1,849856)						-1,849856	-7,399424	-16,648704	-29,597696	-46,2464	-66,594816	-90,642944	-118,390784	-149,838336	-184,9856	-223,832576	-266,379264	-312,625664	-362,571776	-416,2176	-473,563136	-534,608384	-599,353344	-667,798016	-717,910615	-739,9424								
x						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	19,7	20								
53																																				
x * 50,265						53	106	159	212	265	318	371	424	477	530	583	636	689	742	795	848	901	954	1007	1044,1	1060								
Vt Bottle capacity cm^3		1020	1	2	3																															
M1		0,75	Cylindrical >			Conic>																														
Volume **V cm3 Water**			31,4687	50,265	50,265	131,999	51,172837	98,78212	142,964007	183,854658	221,590225	256,306872	288,140755	317,228032	343,704861	367,7074	389,371807	408,83424	426,230857	441,697816	455,371275	467,387392	477,882325	486,992232	494,853271	499,685834	501,6016								
Volume V m3			3,1469E-05	5,0265E-05	0,000050265		5,11728E-05	9,8782E-05	0,00014296	0,00018385	0,00022159	0,00025631	0,00028814	0,00031723	0,0003437	0,00036771	0,00038937	0,00040883	0,00042623	0,0004417	0,00045537	0,00046739	0,00047788	0,00048699	0,00049485	0,00049969	0,0005016								
M=Density * V			0,0314687	0,050265	0,050265	1000	0,051172837	0,09878212	0,14296401	0,18385466	0,22159023	0,25630687	0,28814076	0,31722803	0,34370486	0,3677074	0,38937181	0,40883424	0,42623086	0,44169782	0,45537128	0,46738739	0,47788233	0,48699223	0,49485327	0,49968583	0,5016016								
Rate of reduction in mass with x																																				
M1 Complete Rocket Mass+ water kgs.		0,7499987				0,618																														
Mn			0,71853	0,668265	0,618		0,566827163	0,51921788	0,47503599	0,43414534	0,39640978	0,36169313	0,32985925	0,30077197	0,27429514	0,2502926	0,22862819	0,20916576	0,19176914	0,17630218	0,16262873	0,15061261	0,14011768	0,13100777	0,12314673	0,11831417	0,1163984								
M1/Mn			1,04379594	1,12230732	1,213590129		1,323152363	1,4444778	1,578825	1,72752906	1,89197832	2,07357741	2,27369313	2,49357912	2,73427631	2,99648771	3,28042964	3,5856667	3,91094567	4,25405224	4,61172342	4,97965416	5,35263449	5,72484145	6,09028519	6,33904399	6,44337637								
Tsiolkovsky parameter LN M1/Mn			0,04286401	0,11538667	0,193583016		0,280017043	0,36774787	0,4566809	0,5466921	0,63762301	0,72927533	0,82140544	0,91371908	1,0058668	1,09744084	1,1879744	1,27694443	1,3637792	1,447872	1,52860163	1,60536044	1,67758887	1,74481485	1,80669491	1,84672797	1,86305268								
P1=Pe		7,5																																		
Volume of air cm^3		386,3997	417,8684	468,1334	518,3984		569,571237	617,18052	661,362407	702,253056	739,988625	774,705272	806,539155	835,626432	862,103261	886,1058	907,770207	927,23264	944,629257	960,096216	973,769675	985,785792	996,280725	1005,39063	1013,25167	1018,08423	1020								
P1*V1		2897,99775																																		
Change in air Pressure P2 bar.		7,5	6,9351924	6,19053832	5,590290691		5,088033878	4,69554313	4,38186041	4,12671433	3,91627338	3,74077453	3,59312717	3,46805419	3,36154366	3,27048728	3,19243541	3,12542681	3,06786787	3,01844513	2,97606079	2,93978446	2,90881644	2,88245947	2,86009689	2,8465208	2,84117426		V2>	93,9133	449,526201				
Rate of change of V with x																													a2>	1821,7901	m/s^2				
$3x^2$							3	12	27	48	75	108	147	192	243	300	363	432	507	588	675	768	867	972	1083	1164,27	1200			185,707451	g				
0,022693																																				
$3x^2$ * (0,22693)							0,068079	0,272316	0,612711	1,089264	1,701975	2,450844	3,335871	4,357056	5,514399	6,8079	8,237559	9,803376	11,505351	13,343484	15,317775	17,428224	19,674831	22,057596	24,576519	26,4207791	27,2316								
(-2x)							-2	-4	-6	-8	-10	-12	-14	-16	-18	-20	-22	-24	-26	-28	-30	-32	-34	-36	-38	-39,4	-40								
1,849856																																				
(-2x) * 1,849856							-3,699712	-7,399424	-11,099136	-14,798848	-18,49856	-22,198272	-25,897984	-29,597696	-33,297408	-36,99712	-40,696832	-44,396544	-48,096256	-51,795968	-55,49568	-59,195392	-62,895104	-66,594816	-70,294528	-72,8843264	-73,99424								
53							53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53								
Density Kg/m3	ρ	1000																																		
dV/dx> Proportional to CSA An cm^2 / cm	δ						49,368367	45,872892	42,513575	39,290416	36,203415	33,252572	30,437887	27,75936	25,216991	22,81078	20,540727	18,406832	16,409095	14,547516	12,822095	11,232832	9,779727	8,46278	7,281991	6,53645271	6,23736								
dM/dx gms/cm	δ						49,368367	45,872892	42,513575	39,290416	36,203415	33,252572	30,437887	27,75936	25,216991	22,81078	20,540727	18,406832	16,409095	14,547516	12,822095	11,232832	9,779727	8,46278	7,281991	6,53645271	6,23736								
P1 bar.		8,5	7																																	
m* Kgs/s		12,2588	11,1278																																	
Event time T jet s		0,05155	0,056795																																	
q Mean flowrate Kgs/s		14,5489564	13,2053649																																	
Nozzle area m2		0,00038013	0,00038013																																	
Average Nozzle velocity m/s		38,2733607	34,7388281																																	
Improved nozzle efficiency		1,32	1,32																																	
		50,5208361	45,8552531																																	
		1,86305268	1,86305268																																	
		71,3052873	64,7202669																																	
		94,1229792	85,4307524																																	
F=qV1 + (Pe-Pa) Se																																				
F=qV1 N		733	604	< must correct V1 for different P Use values for Vo below.																																
Specific Impulse **Isp s**		6,08244232	5,52144377																																	
Total impulse during burn time																																				
Total weight of propellant consumed																																				
Excess pressure Pe-Pa bar		4,25	3,5																																	
Effective exhaust velocity m/s		59,6687592	54,1653634																																	
		3,47247149	3,47247149																																	
Nozzle Diameter mm d		22	22	22																																
Nozzle Area m2 Na (p)r2	A1	0,00038013	0,00038013	0,00038013																																
Length of rocket body from tip to nozzle(L) mm		520	520	520																																
Diameter of rocket body (D) mm		80	80	80																																
Aerodynamic ratio L/D		6,5	6,5	6,5																																
Type of bottle used for main reservoir		Badoit	Badoit	Badoit																																
Volume of bottle ml		1000	1000	1000																																
Type of bottle used for payload capsule/ Coiffe		Aix	Aix	Aix																																
Height of liquid level Hydraulic head (h) mm		230	230	230																																
Rocket launch pressure Bar. Pe		7	7,5	8,5																																
Launch pressure in Pa or N/m2		709275	759937,5	861262,5																																
Density of liquid Kgs/m3 Dn (r)	ρ	1000	1000	1000																																
Density of air/gas Kgs/m3 Da		1,1614	1,1614	1,1614																																
Acceleration due to gravity (g) 9,81 m/s2		9,81	9,81	9,81																																
Discharge coefficient 0,97 > 0,998 W	w	0,97	0,97	0,97																																
Coefficient of contraction 0,52 > 0,99 X	z	0,8	0,8	0,8																																
2*g*h		4,5126	4,5126	4,5126																																
2*Pa/Dn		1418,55	1519,875	1722,525																																
Jet velocity V1 from a pressurised reservoir		37,723502	39,0434066	41,5576419																																
V1=W *(2gh+ 2Pa/Dn)$^{0.5}$ Note to power 0.5																																				
Velocity of water jet discharged V1 m/s		36,5917969	37,8721044	40,3109126																																
Vo=V1/g		3,73005065	3,8605611	4,10916541																																
r1							4																													
A1							50,26548246																													
29																																				
197																																				
Tan©							0,147208122	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812	0,14720812								
Radius rn cm							3,852791878	3,70558376	3,55837563	3,41116751	3,26395939	3,11675127	2,96954315	2,82233503	2,6751269	2,52791878	2,38071066	2,23350254	2,08629442	1,93908629	1,79187817	1,64467005	1,49746193	1,35025381	1,20304569	1,1								
Cross sectional Area An cm2							46,63381786	43,1383113	39,7789629	36,5557725	33,4687403	30,5178661	27,7031499	25,0245919	22,4821919	20,07595	17,8058662	15,6719405	13,6741728	11,8125632	10,0871117	8,4978183	7,04468295	5,72770568	4,54688649	3,80132711								
Area An m2							0,004663382	0,00431383	0,0039779	0,00365558	0,00334687	0,00305179	0,00277031	0,00250246	0,00224822	0,0020076	0,00178059	0,00156719	0,00136742	0,00118126	0,00100871	0,00084978	0,00070447	0,00057277	0,00045469	0,00038013	0								
Let Initial C= V1 m/s					8,5b V0>	4,109	4,44195314	4,81707776	5,24180845	5,7252934	6,2788911	6,91684368	7,6572021	8,52311724	9,54467198	10,7615297	12,2268431	14,013169	16,2215731	18,9963552	22,5491239	27,2004232	33,4546445	42,1427625	50,408279		V1>	50,4083						
Continuity Equation An* C = k						0,019161836																			76,57											
						0	0																													
Acceleration dv/dt m/s2							1723,35718	145,538165	164,783974	187,579027	214,780875	247,508276	287,23896	335,951558	396,335493	472,10774	568,501823	693,042041	856,804689	1076,54012	1378,37775	1804,57781	2426,46803	3370,75383	3206,79591		V2>	163,445256						
Time increment dtjet		0,0025775																							Av. Accel1 >	19557,0433	1029,31807		165,310329						
																									Av. Accel2 >	977,852163									
P1=F/A																																				
M2		0,118																																		
F=Ma N		121,459532	397,748952																																	
Tsiol kovski modification M1/M2			741,027253																																	
Acceleration a_0		978,226337																																		
Acceleration a_1		3360,94383																																		
Average accn		2169,58508																																		
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