

FORÇAS CENTRAIS

4,4

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Introdução:

-O experimento tem como objetivo calcular a energia mecânica e o momento angular de um corpo com uma trajetória **elíptica**, com uma força central gravitacional agindo **sobre**. Busca-se analisar e observar o comportamento dessas grandezas com o passar do tempo, verificando se houve conservação ou não das mesmas.

Procedimento experimental:

em relação a que sistema de coordenadas

- Utilizando o programa Solar System Dynamics Group do Jet Propulsion Laboratory, disponibilizado pela NASA, que fornece as posições X, Y e Z de um planeta em torno do Sol e seu período de revolução, será montada uma tabela com as posições no espaço de um determinado planeta em relação ao Sol, no caso apresentado, o planeta em questão é Marte. Com as posições antes mencionadas em 3 dimensões (X,Y,Z), monta-se um novo sistema de referências, onde se analisa o movimento do planeta em seu plano de translação, com novas coordenadas de X e Y referentes a este plano, assim, será calculado a variação de espaço em função do tempo do planeta, para calcular seu momento linear, angular e energia cinética. Com a distância r do planeta ao Sol, também poderá ser calculado a energia potencial do mesmo, somando ambas, será obtida a energia mecânica do sistema. **Afim** de obter uma quantidade considerada de pontos para a análise, a diferença de tempo entre cada ponto foi de 8 dias, essa escolha foi feita baseando-se em analisar uma volta completa do planeta em torno do Sol, sabendo seu período de Translação (687 dias). As fórmulas usadas foram fornecidas pelo professor na apresentação do experimento. Vale ressaltar que as incertezas em cada tabela se referem ao último algarismo significativo que aparece para cada grandezza.

incerteza em x,y, z era para ser 0,001 da medida....

Resultados:

Intervalo	r(m)	inc r(m)	x novo(m)	inc x novo	y novo(m)	inc y novo
1	2,17441E+11	11	1,630954E+11	8	1,438072E+11	7
2	2,188855E+11	11	1,52165E+11	2	1,573422E+11	2

3	2,2037281 E+11	2	1,4031674E+11	1	1,6992759E+ 11	1
4	2,218932E +11	5	1,276378E+11	3	1,815081E+1 1	4
5	2,23437E+ 11	2	1,142188E+11	9	1,92037E+11	1
6	2,24996E+ 11	3	1,00151E+11	2	2,01477E+11	3
7	2,26560E+ 11	6	8,5525E+10	2	2,09797E+11	5
8	2,28120E+ 11	9	7,0433E+10	3	2,16975E+11	8
9	2,2967E+1 1	1	5,4964E+10	3	2,2300E+11	1
10	2,3120E+1 1	2	3,9207E+10	3	2,2785E+11	2
11	2,3270E+1 1	2	2,3247E+10	2	2,3154E+11	2
12	2,3417E+1 1	2	7,1687E+09	7	2,3406E+11	2
13	2,3560E+1 1	3	-8,946E+09	1	2,3543E+11	3
14	2,3698E+1 1	3	-2,5019E+10	3	2,3566E+11	3
15	2,3831E+1 1	4	-4,0974E+10	6	2,3476E+11	4
16	2,3958E+1 1	4	-5,674E+10	1	2,3277E+11	4
17	2,4079E+1 1	5	-7,224E+10	1	2,2970E+11	4
18	2,4194E+1 1	5	-8,742E+10	2	2,2559E+11	5
19	2,4301E+1 1	5	-1,0221E+11	2	2,2047E+11	5
20	2,4400E+1 1	6	-1,1654E+11	3	2,1437E+11	5
21	2,4492E+1 1	6	-1,3037E+11	3	2,0734E+11	5
22	2,4575E+1 1	6	-1,4363E+11	4	1,9941E+11	5
23	2,4650E+1 1	6	-1,5628E+11	4	1,9063E+11	5

24	2,4716E+1 1	6	-1,6827E+11	4	1,8104E+11	5
25	2,4774E+1 1	6	-1,7956E+11	5	1,7069E+11	4
26	2,4822E+1 1	6	-1,9009E+11	5	1,5962E+11	4
27	2,4861E+1 1	6	-1,9984E+11	5	1,4790E+11	4
28	2,4891E+1 1	6	-2,0876E+11	5	1,3556E+11	3
29	2,4911E+1 1	6	-2,1682E+11	5	1,2267E+11	3
30	2,4922E+1 1	6	-2,2399E+11	5	1,0927E+11	3
31	2,4923E+1 1	6	-2,3024E+11	5	9,543E+10	2
32	2,4915E+1 1	6	-2,3555E+11	5	8,120E+10	2
33	2,4897E+1 1	5	-2,3989E+11	5	6,663E+10	1
34	2,4870E+1 1	5	-2,4325E+11	5	5,179E+10	1
35	2,4833E+1 1	5	-2,4560E+11	5	3,6738E+10	7
36	2,4787E+1 1	4	-2,4694E+11	4	2,1535E+10	4
37	2,4732E+1 1	4	-2,4724E+11	4	6,2429E+09	1
38	2,4668E+1 1	3	-2,4652E+11	3	-9,0742E+09	1
39	2,4596E+1 1	3	-2,4475E+11	3	-2,4352E+10	3
40	2,4514E+1 1	3	-2,4194E+11	3	-3,9525E+10	4
41	2,4425E+1 1	2	-2,3808E+11	2	-5,4526E+10	5
42	2,4327E+1 1	2	-2,3320E+11	2	-6,9290E+10	5
43	2,4222E+1 1	2	-2,2728E+11	1	-8,3747E+10	5
44	2,4110E+1 1	1	-2,2035E+11	1	-9,7830E+10	5

45	2,39903E+11	9	-2,12433E+11	8	-1,11471E+11	4
46	2,38646E+11	6	-2,03536E+11	5	-1,24598E+11	3
47	2,37329E+11	4	-1,93692E+11	3	-1,3714E+11	2
48	2,35959E+11	2	-1,82930E+11	2	-1,49041E+11	1
49	2,345405E+11	8	-1,712871E+11	6	-1,602185E+11	5
50	2,330796E+11	1	-1,5880370E+11	8	-1,7060918E+11	8
51	2,3158307E+11	5	-1,4552641E+11	3	-1,8014656E+11	4
52	2,300578E+11	6	-1,315073E+11	3	-1,887655E+11	5
53	2,28511E+11	2	-1,168044E+11	9	-1,96403E+11	1
54	2,26951E+11	3	-1,01482E+11	2	-2,02998E+11	3
55	2,25385E+11	6	-8,5609E+10	2	-2,08494E+11	5
56	2,23823E+11	9	-6,9262E+10	3	-2,12837E+11	8
57	2,2227E+11	1	-5,2523E+10	3	-2,1598E+11	1
58	2,2074E+11	2	-3,5481E+10	2	-2,1787E+11	2
59	2,1925E+11	2	-1,8228E+10	2	-2,1849E+11	2
60	2,1779E+11	2	-8,6554E+08	9	-2,1779E+11	2
61	2,1638E+11	3	1,6504E+10	2	-2,1575E+11	3
62	2,1503E+11	3	3,3771E+10	5	-2,1237E+11	3
63	2,1376E+11	4	5,0824E+10	9	-2,0763E+11	4
64	2,1256E+11	4	6,755E+10	1	-2,0154E+11	4
65	2,1145E+11	4	8,383E+10	2	-1,9412E+11	4

66	2,1044E+1 1	5	9,955E+10	2	-1,8540E+11	4
67	2,0953E+1 1	5	1,1459E+11	3	-1,7542E+11	4
68	2,0874E+1 1	5	1,2884E+11	3	-1,6423E+11	4
69	2,0806E+1 1	5	1,4219E+11	4	-1,5189E+11	4
70	2,0752E+1 1	5	1,5455E+11	4	-1,3849E+11	4
71	2,0710E+1 1	5	1,6580E+11	4	-1,2410E+11	3
72	2,0682E+1 1	5	1,7587E+11	4	-1,0882E+11	3
73	2,0667E+1 1	5	1,8468E+11	5	-9,277E+10	2
74	2,0667E+1 1	5	1,9217E+11	4	-7,605E+10	2
75	2,0680E+1 1	4	1,9827E+11	4	-5,878E+10	1
76	2,0707E+1 1	4	2,0295E+11	4	-4,109E+10	8
77	2,0747E+1 1	4	2,0618E+11	4	-4,1093E+10	4
78	2,0801E+1 1	3	2,0795E+11	3	-4,9740E+09	8
79	2,0867E+1 1	3	2,0825E+11	3	1,3200E+10	2
80	2,0945E+1 1	2	2,0710E+11	2	3,1281E+10	3
81	2,1034E+1 1	2	2,0452E+11	2	4,9145E+10	4
82	2,1134E+1 1	1	2,0055E+11	1	6,6673E+10	5
83	2,1244E+1 1	1	1,9524E+11	1	8,3753E+10	4
84	2,13632E+ 11	7	1,88634E+11	7	1,00279E+11	4
85	2,14900E+ 11	5	1,80806E+11	4	1,16152E+11	3
86	2,16239E+ 11	2	1,71824E+11	2	1,31285E+11	2

duas vezes a mesma
tabela?

intervalo	r(m)	inc r(m)	x novo(m)	inc x novo	y novo(m)	inc y novo
1	2,17441E+11	1	1,630954E+11	8	1,438072E+11	7
2	2,188855E+11	2	1,52165E+11	2	1,573422E+11	2
3	2,2037281E+11	2	1,4031674E+11	1	1,6992759E+11	1
4	2,218932E+11	5	1,276378E+11	3	1,815081E+11	4
5	2,23437E+11	2	1,142188E+11	9	1,92037E+11	1
6	2,24996E+11	3	1,00151E+11	2	2,01477E+11	3
7	2,26560E+11	6	8,5525E+10	2	2,09797E+11	5
8	2,28120E+11	9	7,0433E+10	3	2,16975E+11	8
9	2,2967E+11	1	5,4964E+10	3	2,2300E+11	1
10	2,3120E+11	2	3,9207E+10	3	2,2785E+11	2
11	2,3270E+11	2	2,3247E+10	2	2,3154E+11	2
12	2,3417E+11	2	7,1687E+09	7	2,3406E+11	2
13	2,3560E+11	3	-8,946E+09	1	2,3543E+11	3
14	2,3698E+11	3	-2,5019E+10	3	2,3566E+11	3
15	2,3831E+11	4	-4,0974E+10	6	2,3476E+11	4
16	2,3958E+11	4	-5,674E+10	1	2,3277E+11	4
17	2,4079E+11	5	-7,224E+10	1	2,2970E+11	4
18	2,4194E+11	5	-8,742E+10	2	2,2559E+11	5
19	2,4301E+11	5	-1,0221E+11	2	2,2047E+11	5
20	2,4400E+11	6	-1,1654E+11	3	2,1437E+11	5
21	2,4492E+11	6	-1,3037E+11	3	2,0734E+11	5

22	2,4575E+1 1	6	-1,4363E+11	4	1,9941E+11	5
23	2,4650E+1 1	6	-1,5628E+11	4	1,9063E+11	5
24	2,4716E+1 1	6	-1,6827E+11	4	1,8104E+11	5
25	2,4774E+1 1	6	-1,7956E+11	5	1,7069E+11	4
26	2,4822E+1 1	6	-1,9009E+11	5	1,5962E+11	4
27	2,4861E+1 1	6	-1,9984E+11	5	1,4790E+11	4
28	2,4891E+1 1	6	-2,0876E+11	5	1,3556E+11	3
29	2,4911E+1 1	6	-2,1682E+11	5	1,2267E+11	3
30	2,4922E+1 1	6	-2,2399E+11	5	1,0927E+11	3
31	2,4923E+1 1	6	-2,3024E+11	5	9,543E+10	2
32	2,4915E+1 1	6	-2,3555E+11	5	8,120E+10	2
33	2,4897E+1 1	5	-2,3989E+11	5	6,663E+10	1
34	2,4870E+1 1	5	-2,4325E+11	5	5,179E+10	1
35	2,4833E+1 1	5	-2,4560E+11	5	3,6738E+10	7
36	2,4787E+1 1	4	-2,4694E+11	4	2,1535E+10	4
37	2,4732E+1 1	4	-2,4724E+11	4	6,2429E+09	1
38	2,4668E+1 1	3	-2,4652E+11	3	-9,0742E+09	1
39	2,4596E+1 1	3	-2,4475E+11	3	-2,4352E+10	3
40	2,4514E+1 1	3	-2,4194E+11	3	-3,9525E+10	4
41	2,4425E+1 1	2	-2,3808E+11	2	-5,4526E+10	5
42	2,4327E+1 1	2	-2,3320E+11	2	-6,9290E+10	5

43	2,4222E+1 1	2	-2,2728E+11	1	-8,3747E+10	5
44	2,4110E+1 1	1	-2,2035E+11	1	-9,7830E+10	5
45	2,39903E+ 11	9	-2,12433E+11	8	-1,11471E+11	4
46	2,38646E+ 11	6	-2,03536E+11	5	-1,24598E+11	3
47	2,37329E+ 11	4	-1,93692E+11	3	-1,3714E+11	2
48	2,35959E+ 11	2	-1,82930E+11	2	-1,49041E+11	1
49	2,345405E +11	8	-1,712871E+11	6	-1,602185E+1 1	5
50	2,330796E +11	1	-1,5880370E+1 1	8	-1,7060918E+ 11	8
51	2,3158307 E+11	5	-1,4552641E+1 1	3	-1,8014656E+ 11	4
52	2,300578E +11	6	-1,315073E+11	3	-1,887655E+1 1	5
53	2,28511E+ 11	2	-1,168044E+11	9	-1,96403E+11	1
54	2,26951E+ 11	3	-1,01482E+11	2	-2,02998E+11	3
55	2,25385E+ 11	6	-8,5609E+10	2	-2,08494E+11	5
56	2,23823E+ 11	9	-6,9262E+10	3	-2,12837E+11	8
57	2,2227E+1 1	1	-5,2523E+10	3	-2,1598E+11	1
58	2,2074E+1 1	2	-3,5481E+10	2	-2,1787E+11	2
59	2,1925E+1 1	2	-1,8228E+10	2	-2,1849E+11	2
60	2,1779E+1 1	2	-8,6554E+08	9	-2,1779E+11	2
61	2,1638E+1 1	3	1,6504E+10	2	-2,1575E+11	3
62	2,1503E+1 1	3	3,3771E+10	5	-2,1237E+11	3
63	2,1376E+1 1	4	5,0824E+10	9	-2,0763E+11	4

64	2,1256E+1 1	4	6,755E+10	1	-2,0154E+11	4
65	2,1145E+1 1	4	8,383E+10	2	-1,9412E+11	4
66	2,1044E+1 1	5	9,955E+10	2	-1,8540E+11	4
67	2,0953E+1 1	5	1,1459E+11	3	-1,7542E+11	4
68	2,0874E+1 1	5	1,2884E+11	3	-1,6423E+11	4
69	2,0806E+1 1	5	1,4219E+11	4	-1,5189E+11	4
70	2,0752E+1 1	5	1,5455E+11	4	-1,3849E+11	4
71	2,0710E+1 1	5	1,6580E+11	4	-1,2410E+11	3
72	2,0682E+1 1	5	1,7587E+11	4	-1,0882E+11	3
73	2,0667E+1 1	5	1,8468E+11	5	-9,277E+10	2
74	2,0667E+1 1	5	1,9217E+11	4	-7,605E+10	2
75	2,0680E+1 1	4	1,9827E+11	4	-5,878E+10	1
76	2,0707E+1 1	4	2,0295E+11	4	-4,109E+10	8
77	2,0747E+1 1	4	2,0618E+11	4	-4,1093E+10	4
78	2,0801E+1 1	3	2,0795E+11	3	-4,9740E+09	8
79	2,0867E+1 1	3	2,0825E+11	3	1,3200E+10	2
80	2,0945E+1 1	2	2,0710E+11	2	3,1281E+10	3
81	2,1034E+1 1	2	2,0452E+11	2	4,9145E+10	4
82	2,1134E+1 1	1	2,0055E+11	1	6,6673E+10	5
83	2,1244E+1 1	1	1,9524E+11	1	8,3753E+10	4
84	2,13632E+ 11	7	1,88634E+11	7	1,00279E+11	4

massas?

85	2,14900E+11	5	1,80806E+11	4	1,16152E+11	3
86	2,16239E+11	2	1,71824E+11	2	1,31285E+11	2

A tabela 1 indica as posições novas encontradas após se estabelecer um novo sistema de referências no plano de translação, como mencionado no procedimento experimental.

dr?

TABELA 2

não era para calcular para todos os pontos...

V(m/s)	σV	momento linear P	σP	Momento angular	Inc L	
				unidades?	algo errado na conta...	
2,48E+04		2	1,59E+28	1	3,57E+38	2
2,47E+04		6	1,58E+28	4	8,84E+38	2
2,45E+04		2	1,57E+28	1	1,39E+39	3
2,43E+04		4	1,56E+28	3	1,85E+39	4
2,42E+04		6	1,55E+28	4	2,27E+39	2
2,40E+04		9	1,54E+28	6	2,64E+39	2
2,39E+04		1	1,531E+28	8	2,95E+39	4
2,37E+04		2	1,52E+28	1	3,19E+39	3
2,35E+04		2	1,51E+28	1	3,37E+39	2
2,34E+04		2	1,50E+28	2	3,48E+39	4
2,33E+04		3	1,49E+28	2	3,52E+39	5
2,31E+04		3	1,48E+28	2	3,50E+39	6
2,30E+04		4	1,48E+28	2	3,50E+39	6
2,29E+04		4	1,47E+28	3	3,50E+39	7
2,27E+04		4	1,46E+28	3	3,50E+39	7
2,26E+04		5	1,45E+28	3	3,50E+39	6
2,25E+04		5	1,45E+28	3	3,51E+39	5
2,24E+04		5	1,44E+28	3	3,51E+39	4
2,23E+04		5	1,43E+28	3	3,51E+39	5
2,23E+04		5	1,43E+28	4	3,51E+39	3
2,22E+04		6	1,42E+28	4	3,51E+39	4
2,21E+04		6	1,42E+28	4	3,51E+39	5
2,21E+04		6	1,42E+28	4	3,51E+39	5
2,20E+04		6	1,41E+28	4	3,51E+39	5
2,20E+04		6	1,41E+28	4	3,51E+39	5

ângulo teta?

2,20E+04	6	1,41E+28	4	3,51E+39	5
2,19E+04	5	1,41E+28	4	3,51E+39	6
2,19E+04	5	1,41E+28	3	3,51E+39	7
2,19E+04	5	1,41E+28	3	3,51E+39	7
2,19E+04	5	1,41E+28	3	3,51E+39	6
2,19E+04	5	1,41E+28	3	3,51E+39	6
2,20E+04	4	1,41E+28	3	3,51E+39	7
2,20E+04	4	1,41E+28	3	3,51E+39	7
2,20E+04	4	1,41E+28	2	3,50E+39	6
2,21E+04	3	1,42E+28	2	3,51E+39	6
2,22E+04	3	1,42E+28	2	3,48E+39	7
2,22E+04	3	1,43E+28	2	3,40E+39	6
2,23E+04	2	1,43E+28	2	3,26E+39	6
2,24E+04	2	1,44E+28	1	3,06E+39	7
2,25E+04	2	1,44E+28	1	2,81E+39	6
2,26E+04	1	1,450E+28	9	2,51E+39	5
2,27E+04	1	1,457E+28	7	2,16E+39	6
2,28E+04	1	1,464E+28	5	1,76E+39	5
2,29E+04	1	1,472E+28	4	1,34E+39	6
2,31E+04	4	1,48E+28	3	8,82E+38	7
2,32E+04	2	1,49E+28	1	4,06E+38	5
2,34E+04	1	1,499E+28	6	8,16E+37	6
2,35E+04	1	1,508E+28	6	5,72E+38	7
2,37E+04	1	1,518E+28	6	1,06E+39	5
2,38E+04	1	1,528E+28	6	1,52E+39	4
2,40E+04	2	1,54E+28	1	1,96E+39	3
2,41E+04	4	1,55E+28	3	2,37E+39	4
2,43E+04	6	1,56E+28	4	2,72E+39	4
2,45E+04	1	1,570E+28	6	3,02E+39	5
2,46E+04	1	1,581E+28	8	3,26E+39	4
2,48E+04	2	1,59E+28	1	3,42E+39	4
2,50E+04	2	1,60E+28	1	3,50E+39	3
2,51E+04	3	1,61E+28	2	3,50E+39	4
2,53E+04	3	1,62E+28	2	3,50E+39	6
2,54E+04	4	1,63E+28	2	3,50E+39	6
2,56E+04	4	1,64E+28	3	3,50E+39	7
2,57E+04	5	1,65E+28	3	3,50E+39	4

2,58E+04	5	1,66E+28	3	3,50E+39	5
2,60E+04	6	1,67E+28	4	3,50E+39	6
2,61E+04	6	1,67E+28	4	3,50E+39	7
2,61E+04	7	1,68E+28	4	3,50E+39	5
2,62E+04	7	1,68E+28	4	3,50E+39	5
2,63E+04	7	1,69E+28	4	3,50E+39	5
2,63E+04	7	1,69E+28	4	3,50E+39	6
2,64E+04	7	1,69E+28	4	3,50E+39	7
2,64E+04	6	1,69E+28	4	3,50E+39	5
2,64E+04	6	1,69E+28	4	3,50E+39	4
2,02E+04	4	1,30E+28	3	2,68E+39	5
2,63E+04	5	1,69E+28	3	3,50E+39	4
2,63E+04	5	1,69E+28	3	3,48E+39	3
2,62E+04	4	1,68E+28	3	3,50E+39	6
3,26E+04	4	2,09E+28	3	4,36E+39	5
2,61E+04	3	1,67E+28	2	3,39E+39	5
2,59E+04	2	1,67E+28	1	3,20E+39	5
2,58E+04	2	1,66E+28	1	2,93E+39	4
2,57E+04	1	1,650E+28	8	2,58E+39	3
2,56E+04	1	1,641E+28	6	2,16E+39	6

A tabela 2 mostra o resultado do cálculo da velocidade e do momento linear, juntamente com suas respectivas incertezas. A velocidade é calculada utilizando 5 pontos, onde subtrai-se a as posições do quinto instante pelo da primeira, obtendo a velocidade no instante 3

O momento linear foi obtido ao multiplicar a velocidade, recém calculada, e a massa de Marte.

O momento angular foi obtido fazendo-se o produto escalar de r por v de cada instante, o ângulo B foi obtido através da projeção de r e V em seus respectivos intervalos.

TABELA 3

unidades?

Intervalo T	Energia Cinética	σ_{Ec}	Energia Potencial	σ_{Epot}	E mecanica	σ_{Emec}
1	1,9792E+32	5	-3,8659E+32	2	-1,887E+32	6
2	1,953E+32	5	-3,8395E+32	2	-1,89E+32	5
3	1,9274E+32	5	-3,8129E+32	2	-1,8855E+32	6
4	1,902E+32	2	-3,7865E+32	2	-1,8849E+32	2
5	1,876E+32	5	-3,7604E+32	2	-1,8842E+32	5
6	1,85E+32	1	-3,7346E+32	2	-1,8836E+32	1

7	1,8265E+32	2	-3,7095E+32	3	-1,8829E+32	4
8	1,8026E+32	4	-3,6849E+32	3	-1,8823E+32	5
9	1,7794E+32	5	-3,6611E+32	4	-1,8817E+32	6
10	1,7571E+32	8	-3,6381E+32	4	-1,8811E+32	9
11	1,736E+32	1	-3,6161E+32	5	-1,8805E+32	1
12	1,715E+32	1	-3,5950E+32	5	-1,8799E+32	1
13	1,696E+32	2	-3,5749E+32	6	-1,8794E+32	2
14	1,677E+32	2	-3,5559E+32	6	-1,8789E+32	2
15	1,660E+32	2	-3,5381E+32	7	-1,8785E+32	2
16	1,643E+32	3	-3,5214E+32	7	-1,8781E+32	3
17	1,628E+32	3	-3,5059E+32	8	-1,8777E+32	3
18	1,614E+32	3	-3,4916E+32	8	-1,8774E+32	3
19	1,601E+32	4	-3,4785E+32	8	-1,8771E+32	4
20	1,590E+32	4	-3,4667E+32	9	-1,8769E+32	4
21	1,579E+32	4	-3,4562E+32	9	-1,8767E+32	4
22	1,570E+32	4	-3,4469E+32	9	-1,8765E+32	4
23	1,562E+32	4	-3,4389E+32	9	-1,8764E+32	4
24	1,556E+32	4	-3,4322E+32	9	-1,8763E+32	4
25	1,551E+32	4	-3,4268E+32	9	-1,8763E+32	4
26	1,546E+32	4	-3,4227E+32	9	-1,8763E+32	4
27	1,544E+32	4	-3,4199E+32	9	-1,8763E+32	4
28	1,542E+32	4	-3,4185E+32	9	-1,8764E+32	4
29	1,542E+32	3	-3,4183E+32	8	-1,8765E+32	4
30	1,543E+32	3	-3,4194E+32	8	-1,8767E+32	3
31	1,545E+32	3	-3,4219E+32	8	-1,8768E+32	3
32	1,549E+32	3	-3,4256E+32	7	-1,8770E+32	3
33	1,553E+32	2	-3,4307E+32	7	-1,8773E+32	2
34	1,559E+32	2	-3,4370E+32	6	-1,8775E+32	2
35	1,567E+32	2	-3,4447E+32	6	-1,8778E+32	2
36	1,575E+32	1	-3,4536E+32	5	-1,8781E+32	1
37	1,585E+32	1	-3,4638E+32	5	-1,8785E+32	1
38	1,5965E+32	8	-3,4753E+32	4	-1,8788E+32	9
39	1,6089E+32	6	-3,4881E+32	4	-1,8792E+32	7
40	1,6225E+32	4	-3,5020E+32	3	-1,8796E+32	5
41	1,6373E+32	3	-3,5173E+32	3	-1,8799E+32	4
42	1,6533E+32	2	-3,5337E+32	3	-1,8804E+32	3
43	1,6705E+32	1	-3,5512E+32	2	-1,8808E+32	3

44	1,68876E+32	7	-3,5699E+32	2	-1,8812E+32	2
45	1,708E+32	2	-3,5897E+32	2	-1,8816E+32	2
46	1,7286E+32	5	-3,6106E+32	2	-1,8820E+32	6
47	1,7500E+32	2	-3,6324E+32	2	-1,8824E+32	2
48	1,7724E+32	2	-3,6552E+32	2	-1,8828E+32	2
49	1,7956E+32	2	-3,6788E+32	2	-1,8832E+32	2
50	1,8196E+32	2	-3,7032E+32	2	-1,8836E+32	3
51	1,8443E+32	5	-3,7283E+32	2	-1,8840E+32	6
52	1,870E+32	2	-3,7539E+32	2	-1,8843E+32	2
53	1,895E+32	5	-3,7800E+32	2	-1,8846E+32	5
54	1,9214E+32	1	-3,8064E+32	2	-1,8849E+32	3
55	1,9477E+32	2	-3,8329E+32	3	-1,8852E+32	4
56	1,9739E+32	4	-3,8594E+32	3	-1,8855E+32	5
57	2,0001E+32	7	-3,8858E+32	4	-1,8858E+32	8
58	2,026E+32	1	-3,9118E+32	5	-1,8860E+32	1
59	2,051E+32	1	-3,9373E+32	6	-1,8862E+32	2
60	2,075E+32	2	-3,9619E+32	6	-1,8864E+32	2
61	2,099E+32	2	-3,9856E+32	7	-1,8867E+32	3
62	2,121E+32	3	-4,0081E+32	8	-1,8869E+32	3
63	2,142E+32	4	-4,0291E+32	9	-1,8871E+32	4
64	2,161E+32	4	-4,0485E+32	9	-1,8873E+32	5
65	2,179E+32	5	-4,066E+32	1	-1,888E+32	5
66	2,194E+32	6	-4,081E+32	1	-1,888E+32	6
67	2,207E+32	6	-4,095E+32	1	-1,888E+32	6
68	2,217E+32	6	-4,105E+32	1	-1,888E+32	6
69	2,225E+32	6	-4,114E+32	1	-1,888E+32	6
70	2,231E+32	6	-4,119E+32	1	-1,889E+32	6
71	2,233E+32	5	-4,122E+32	1	-1,889E+32	6
72	2,233E+32	5	-4,122E+32	1	-1,889E+32	5
73	1,315E+32	2	-4,1197E+32	9	-2,8050E+32	3
74	2,225E+32	4	-4,1144E+32	8	-1,8896E+32	4
75	2,217E+32	3	-4,1309E+32	8	-1,9143E+32	3
76	2,206E+32	2	-4,0958E+32	7	-1,8899E+32	2
77	3,419E+32	4	-4,0828E+32	6	-6,6360E+31	3
78	2,178E+32	1	-4,0676E+32	5	-1,8899E+32	1
79	2,1605E+32	7	-4,0503E+32	4	-1,8898E+32	8
80	2,1414E+32	4	-4,0311E+32	4	-1,8897E+32	6

81	2,1208E+32	3	-4,0102E+32	3	-1,8894E+32	4
82	2,0988E+32	2	-3,9879E+32	3	-1,8892E+32	3

A Tabela 3 mostra o resultado das cálculos das energias cinética, potencial e da energia mecânica

E mecanica	σ Emec	Emec media	Teste Z
		-3,7E+43	
			impossível...
-1,887E+32	6	Desv Pad	0
-1,89E+32	5	2,5E+42	0
-1,8855E+32	6		0
-1,8849E+32	2	Desvio Padrão da Médi	0
-1,8842E+32	5	3E+41	0
-1,8836E+32	1		0
-1,8829E+32	4		0
-1,8823E+32	5		0
-1,8817E+32	6		0
-1,8811E+32	9		0
-1,8805E+32	1		0
-1,8799E+32	1		0
-1,8794E+32	2		0
-1,8789E+32	2		0
-1,8785E+32	2		0
-1,8781E+32	3		0
-1,8777E+32	3		0
-1,8774E+32	3		0
-1,8771E+32	4		0
-1,8769E+32	4		0
-1,8767E+32	4		0
-1,8765E+32	4		0
-1,8764E+32	4		0
-1,8763E+32	4		0
-1,8763E+32	4		0
-1,8763E+32	4		0
-1,8763E+32	4		0

-1,8764E+32	4		0
-1,8765E+32	4		0
-1,8767E+32	3		0
-1,8768E+32	3		0
-1,8770E+32	3		0
-1,8773E+32	2		0
-1,8775E+32	2		0
-1,8778E+32	2		0
-1,8781E+32	1		0
-1,8785E+32	1		0
-1,8788E+32	9		0
-1,8792E+32	7		0
-1,8796E+32	5		0
-1,8799E+32	4		0
-1,8804E+32	3		0
-1,8808E+32	3		0
-1,8812E+32	2		0
-1,8816E+32	2		0
-1,8820E+32	6		0
-1,8824E+32	2		0
-1,8828E+32	2		0
-1,8832E+32	2		0
-1,8836E+32	3		0
-1,8840E+32	6		0
-1,8843E+32	2		0
-1,8846E+32	5		0
-1,8849E+32	3		0
-1,8852E+32	4		0
-1,8855E+32	5		0
-1,8858E+32	8		0
-1,8860E+32	1		0
-1,8862E+32	2		0
-1,8864E+32	2		0
-1,8867E+32	3		0
-1,8869E+32	3		0
-1,8871E+32	4		0
-1,8873E+32	5		0

-1,888E+32	5		0
-1,888E+32	6		0
-1,888E+32	6		0
-1,888E+32	6		0
-1,888E+32	6		0
-1,889E+32	6		0
-1,889E+32	6		0
-1,889E+32	5		1
-2,8050E+32	3		49
-1,8896E+32	4		1
-1,9143E+32	3		2
-1,8899E+32	2		1
-6,6360E+31	3		64
-1,8899E+32	1		1
-1,8898E+32	8		1
-1,8897E+32	6		1
-1,8894E+32	4		1
-1,8892E+32	3		1

Tabela referente ao teste Z feito a partir do desvio padrão da média, da média e dos valores da energia mecânica para cada instante .

GRÁFICO 1 (Energia Cinética x Tempo)

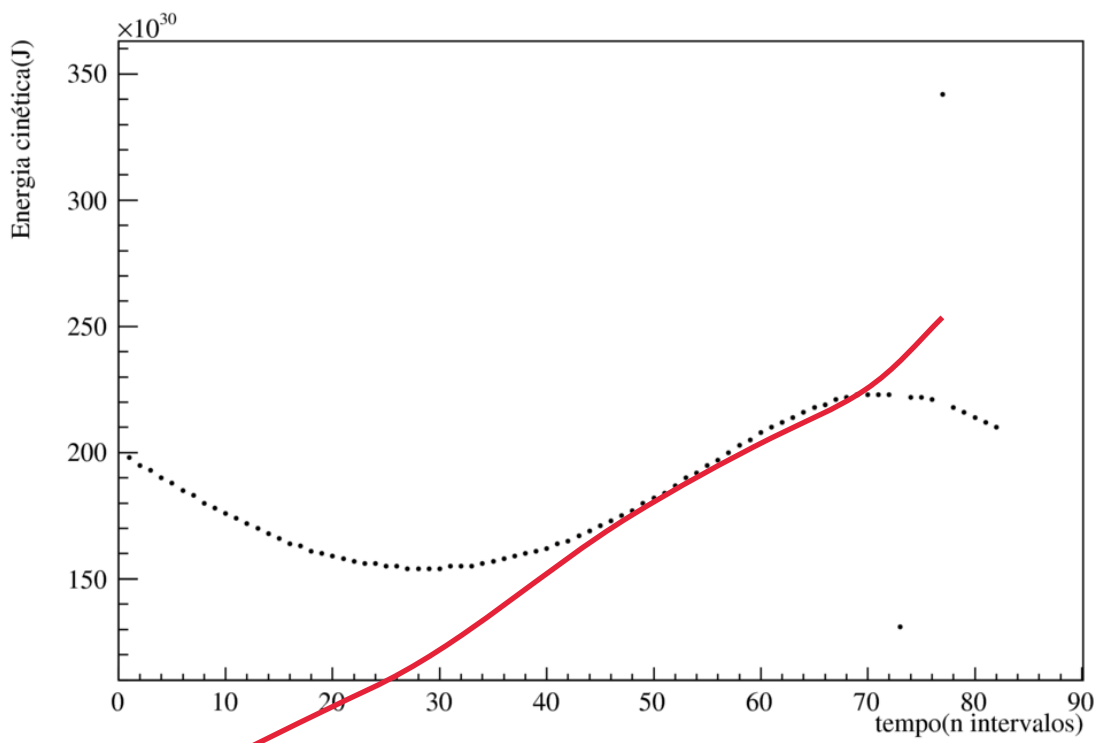


Gráfico 1 : Gráfico da energia cinética em função do tempo, vale a pena destacar que há dois pontos no gráfico que estão grosseiramente errados, tratando-se provavelmente de um erro de medida.

Os dados desse gráfico foram calculados utilizando a massa do planeta e a sua velocidade, através da equação $E_c = \frac{1}{2} \cdot m \cdot v^2$

GRÁFICO 2 (Energia Potencial x Tempo)

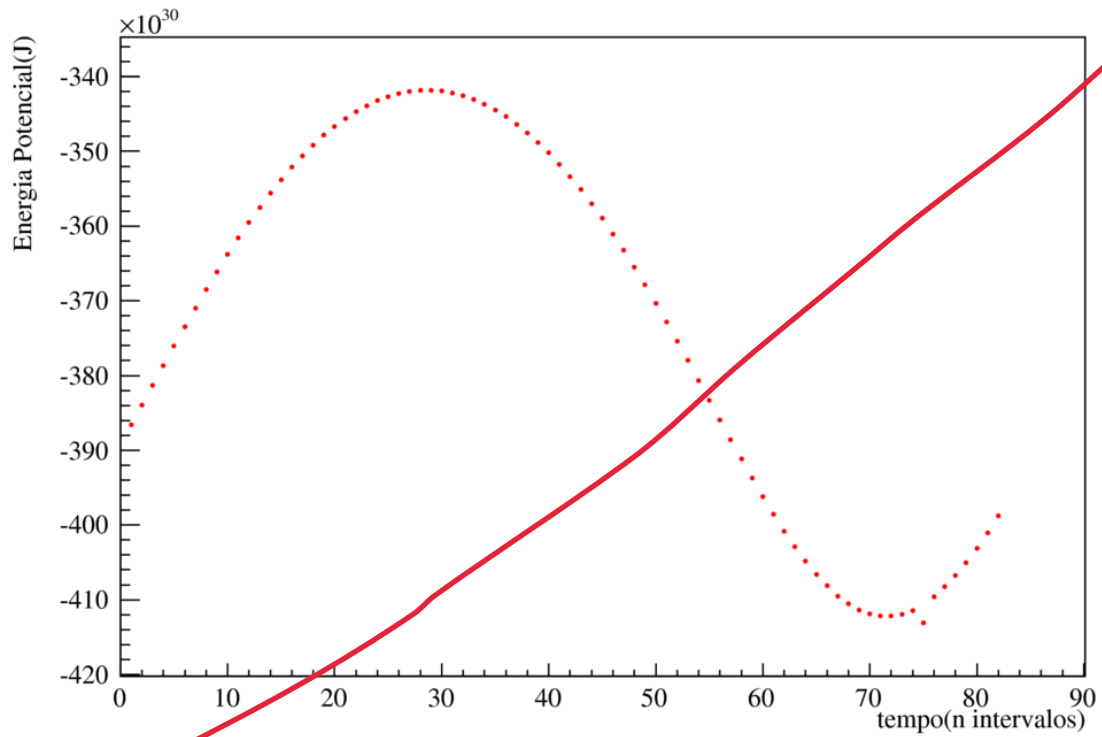


Gráfico 2: Gráfico da energia Potencial em função do tempo.

Por se tratar de uma força gravitacional, a energia potencial é calculada utilizando a constante gravitacional G, a massa do sol M, a massa de Marte m e o raio de órbita de de Marte em torno do Sol r, pela equação: $-(G \cdot M \cdot m) / r$

GRÁFICO 3 (Energia Mecânica x Tempo)

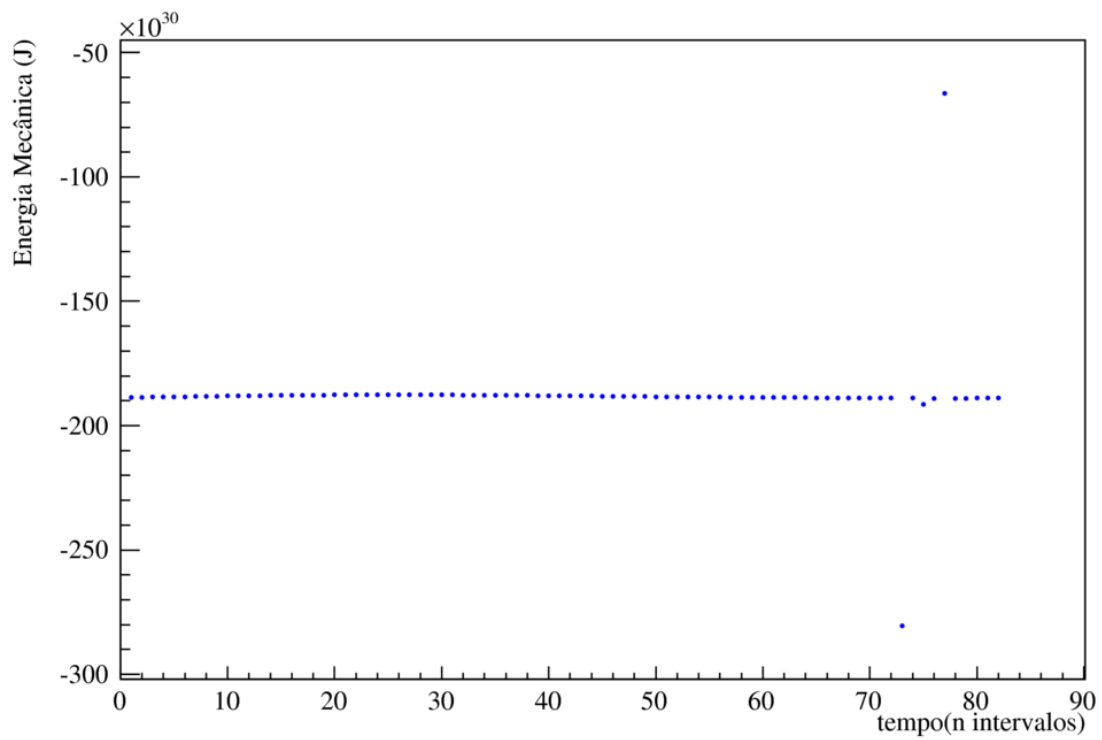


Gráfico 3: Gráfico da energia mecânica em função do tempo. Ressalta-se que os dois pontos afastados da reta representa erros experimentais na medida.

A Energia Mecânica é obtida através da soma da energia cinética e da energia potencial.

GRÁFICO 4 (Energia x Tempo)

ajuste?coeficiente
angular

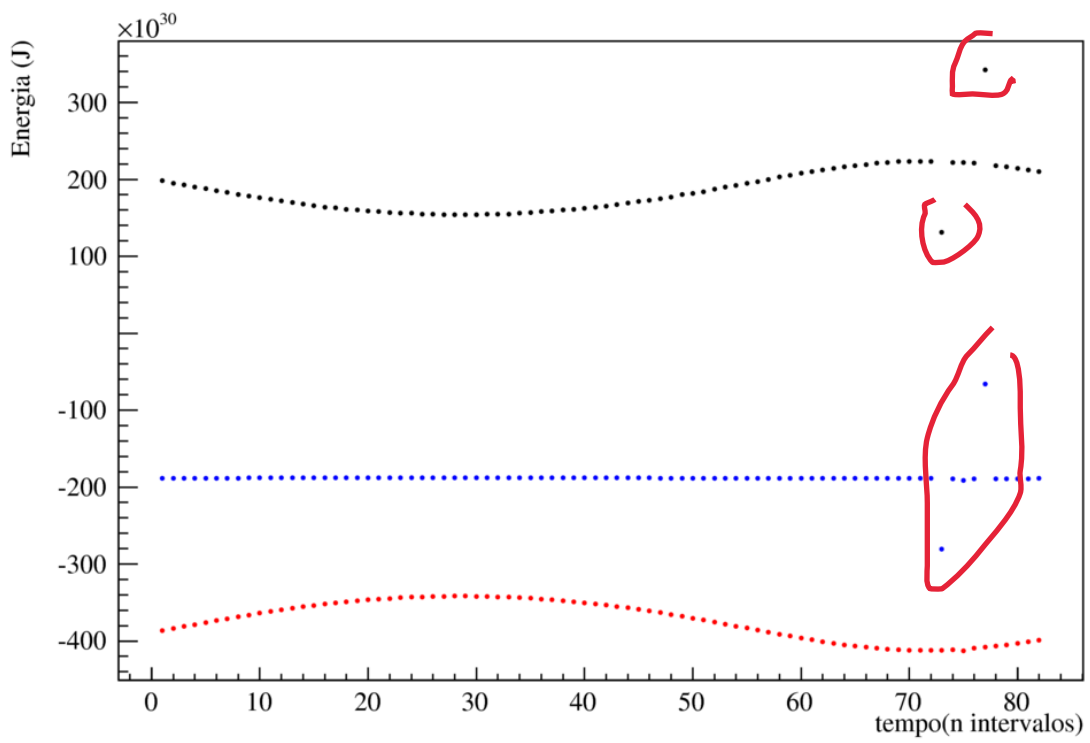
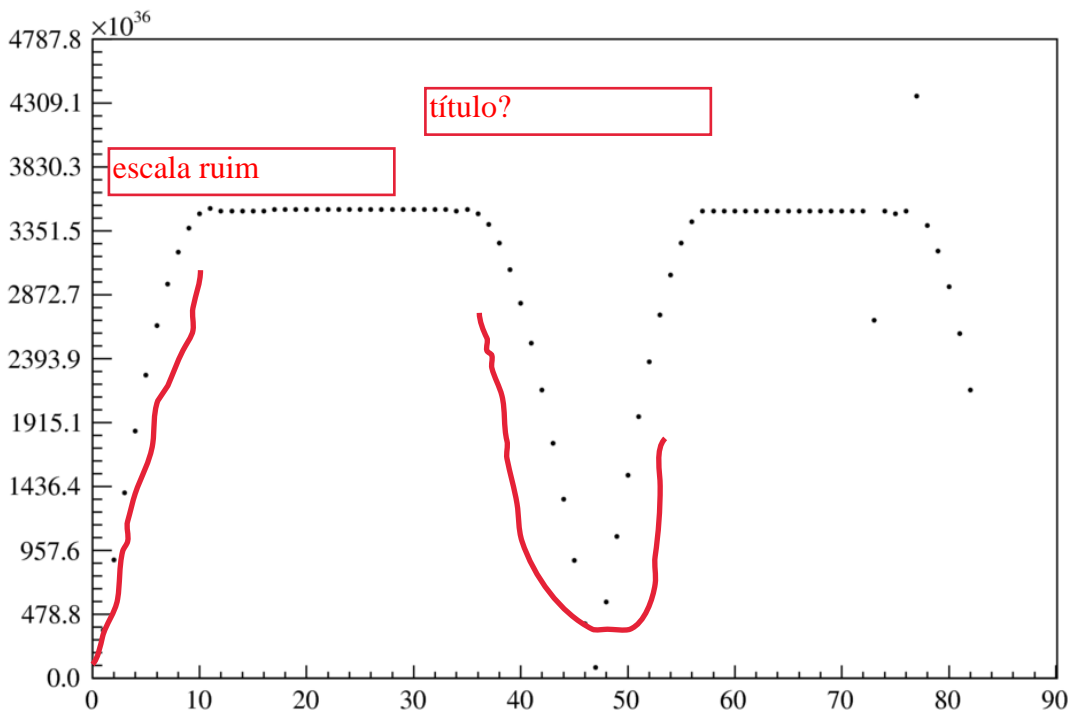
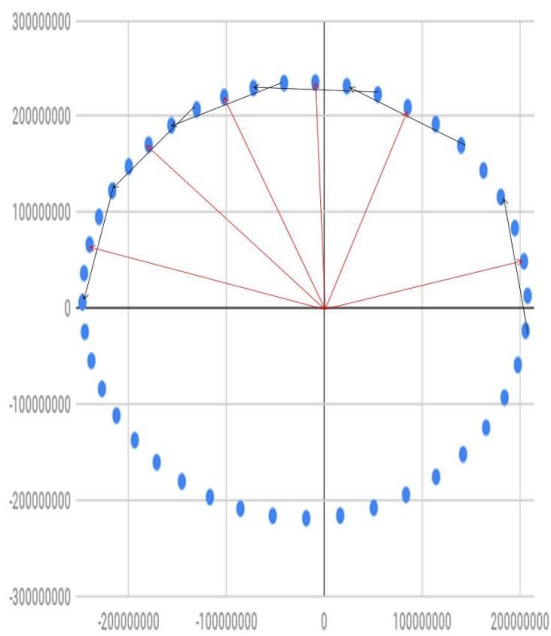


Gráfico 4: Junção dos Gráficos 1,2 e 3, nota-se os dois pontos que representam erros experimentais de medida



Momento angular em função do tempo , sendo L com unidades do SI e t como o nésimo intervalo de tempo

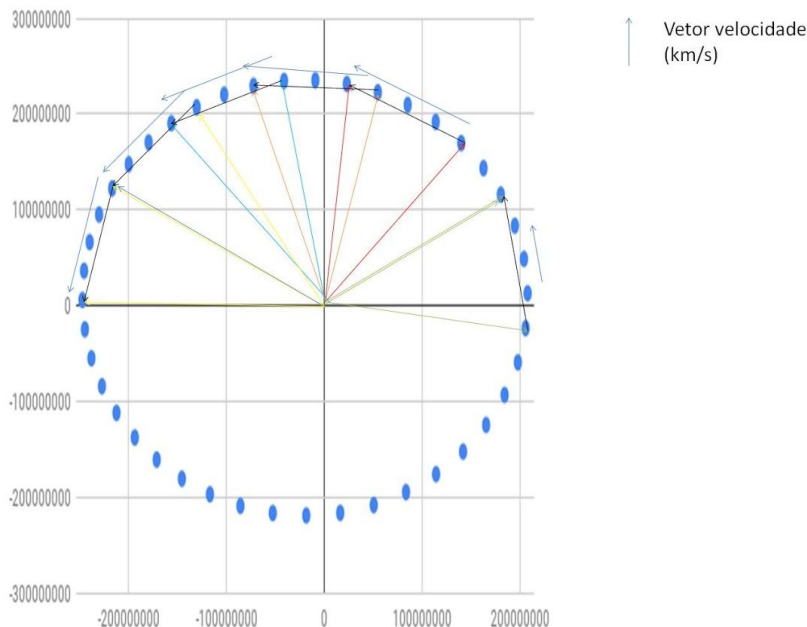


coeficientes?

Vetores r

Vetor dr

Cada quadrado vale 10^6 km, valendo ressaltar que o vetor momento angular aponta para fora do esboço, ou seja, na direção de quem olha o mesmo.



Cada 2cm(1 quadrado) vale 20km/s de velocidade para os vetores de velocidade, enquanto para as distâncias, permanece 10^6 km

Discussão :

não com o valor
médio que vc
colocou na tabela...

-Nota-se que os valores obtidos para a energia mecânica do sistema foram muito próximos de si, com nível de compatibilidade variando de 1 a 2 sigmas, com exceção dos dois pontos experimentais que são erros de conta ou de medida, visto que estão absurdamente fora do comportamento esperado e observado. Vê-se no gráfico 3 e 4 que praticamente não há variação na quantidade de energia mecânica de marte em relação ao Sol, o que nos indica uma conservação desta grandeza.

-O momento angular mostrou-se igualmente conservado, havendo variações durante seu trajeto, mas restaurando-se ao final de seu movimento, nota-se que há um movimento periódico do mesmo

algo periodicamente
errado na conta...

- O objetivo do experimento foi alcançado, sendo demonstrado que houve conservação de energia e do momento angular no período observado, também pode-se constatar que há uma boa precisão dos dados coletados, o que facilitou a análise de dados e montagem de gráficos e tabelas.

comparação entre
alunos...
Incertezas?