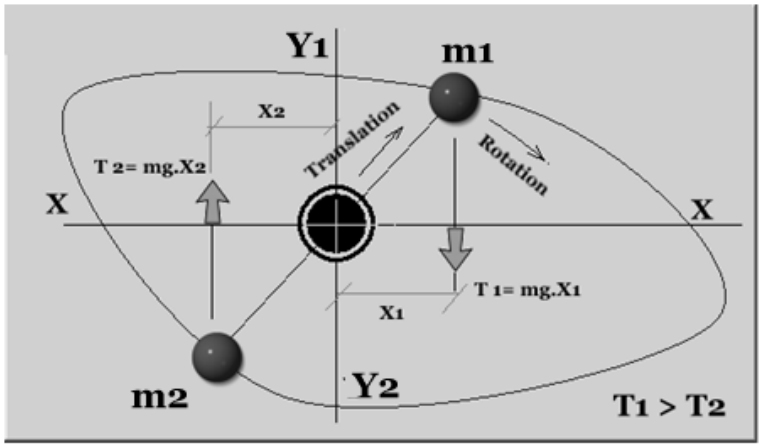
MPP Part 2 /A

Theoretical results



Let us consider one spoke aligned with YY axis as initial position.

Let us assume that there is no friction, and the spoke can translate and rotate along the perpendicular axis to the plan containing the curve.

Let us assume the curved path to be nsr-Bessler curve.

Let us assume that mg = 1 (unit masses).

T1 = torque due to mass m1 = X1

T2 = torque due to mass m2 = X2 (of course from above assumptions m1= m2 = 1)

If T1 > T2, the body should start rotating unaided.

Let us define a general state S of the system as a tuple $(\omega_1, \omega_2, \theta_1, \theta_2)$

W1, w2 are masses associated with angles θ1 and θ2 in general.

In our case w1 = w2 and θ2 = θ1 + 180.

When m1 is at Y1 position, m2 is at Y2 . Let us call that as initial state.

Initial state S0 = $(m_1, m_2, 90^0, 270^0)$

S0 = $\left(m\ ,m,90^0,270^0\right)$

As clockwise rotation takes place when the masses align with x-axis

Let the state be S1

S1 = $\left(m\ ,m,0^0,180^0\right)$

As the system further rotates and as m1 aligns with Y2 and m2 aligns with m1 (that is the system rotated through 180 degrees clockwise) let us name the state as S3

S3 = $\left(m\ ,m,-90^0,90^0\right)$

Since both masses are identical S3 = S0

Hence it is just sufficient to study the state transitions from S0 to S1 to S3 to describe infinite other states.

The following is the computer generated net torque on the system as it transits from S0 to S1 and S3.

θ	**rad**	X1-X2
90.000	1.571	0.00
89.000	1.554	0.102591887
88.000	1.537	0.208492431
87.000	1.519	0.315140893
86.000	1.502	0.422502944
85.000	1.484	0.530543299
84.000	1.467	0.63922573
83.000	1.449	0.748513081
82.000	1.432	0.858367283
81.000	1.414	0.968749373
80.000	1.397	1.079619515
79.000	1.379	1.190937012
78.000	1.362	1.302660335
77.000	1.344	1.414747141
76.000	1.327	1.527154296

75.000	1.310	1.639837899
74.000	1.292	1.75275331
73.000	1.275	1.865855172
72.000	1.257	1.97909744
71.000	1.240	2.092433411
70.000	1.222	2.20581575
69.000	1.205	2.319196522
68.000	1.187	2.432527221
67.000	1.170	2.545758804
66.000	1.152	2.658841722
65.000	1.135	2.771725957
64.000	1.117	2.884361049
63.000	1.100	2.996696137
62.000	1.083	3.108679995
61.000	1.065	3.220261062
60.000	1.048	3.331387487
59.000	1.030	3.442007162
58.000	1.013	3.552067758
57.000	0.995	3.66151677
56.000	0.978	3.770301552
55.000	0.960	3.878369355
54.000	0.943	3.98566737
53.000	0.925	4.09214277
52.000	0.908	4.197742745
51.000	0.890	4.302414547
50.000	0.873	4.40610553
49.000	0.856	4.508763192
48.000	0.838	4.610335217
47.000	0.821	4.710769511
46.000	0.803	4.810014254
45.000	0.786	4.908017933
44.000	0.768	5.004729385
43.000	0.751	5.100097843
42.000	0.733	5.194072973
41.000	0.716	5.286604916
40.000	0.698	5.377644332
39.000	0.681	5.467142435
38.000	0.663	5.555051041
37.000	0.646	5.641322601
36.000	0.629	5.725910246
35.000	0.611	5.808767825

34.000	0.594	5.889849941
33.000	0.576	5.969111993
32.000	0.559	6.046510213
31.000	0.541	6.122001702
30.000	0.524	6.195544468
29.000	0.506	6.267097461
28.000	0.489	6.336620609
27.000	0.471	6.404074852
26.000	0.454	6.469422174
25.000	0.437	6.532625641
24.000	0.419	6.593649426
23.000	0.402	6.652458847
22.000	0.384	6.709020393
21.000	0.367	6.763301752
20.000	0.349	6.815271843
19.000	0.332	6.864900843
18.000	0.314	6.91216021
17.000	0.297	6.957022709
16.000	0.279	6.999462439
15.000	0.262	7.039454851
14.000	0.244	7.076976773
13.000	0.227	7.112006432
12.000	0.210	7.144523468
11.000	0.192	7.174508954
10.000	0.175	7.201945418
9.000	0.157	7.226816849
8.000	0.140	7.24910872
7.000	0.122	7.268807996
6.000	0.105	7.285903145
5.000	0.087	7.300384154
4.000	0.070	7.312242529
3.000	0.052	7.321471312
2.000	0.035	7.328065081
1.000	0.017	7.332019954
0.000	0.000	7.3333336
-1.000	-0.017	7.332005232
-2.000	-0.035	7.328035613
-3.000	-0.052	7.321427055
-4.000	-	7.312183415

	0.070	
-5.000	-0.087	7.300310093
-6.000	-0.105	7.285814027
-7.000	-0.122	7.268703686
-8.000	-0.140	7.248989065
-9.000	-0.157	7.226681672
-10.000	-0.175	7.201794522
-11.000	-0.192	7.174342122
-12.000	-0.210	7.144340461
-13.000	-0.227	7.111806993
-14.000	-0.244	7.076760624
-15.000	-0.262	7.039221695
-16.000	-0.279	6.999211963
-17.000	-0.297	6.956754581
-18.000	-0.314	6.911874079
-19.000	-0.332	6.864596345
-20.000	-0.349	6.814948594
-21.000	-0.367	6.762959355
-22.000	-0.384	6.708658437
-23.000	-0.402	6.652076908
-24.000	-0.419	6.593247064
-25.000	-0.437	6.532202405
-26.000	-0.454	6.468977604
-27.000	-0.471	6.403608475

-28.000	-0.489	6.336131944
-29.000	-0.506	6.266586018
-30.000	-0.524	6.195009748
-31.000	-0.541	6.1214432
-32.000	-0.559	6.045927419
-33.000	-0.576	5.968504391
-34.000	-0.594	5.889217013
-35.000	-0.611	5.808109048
-36.000	-0.629	5.725225098
-37.000	-0.646	5.640610555
-38.000	-0.663	5.554311575
-39.000	-0.681	5.466375026
-40.000	-0.698	5.376848459
-41.000	-0.716	5.285780063
-42.000	-0.733	5.193218628
-43.000	-0.751	5.0992135
-44.000	-0.768	5.003814544
-45.000	-0.786	4.907072102
-46.000	-0.803	4.809036952
-47.000	-0.821	4.709760264
-48.000	-0.838	4.609293564
-49.000	-0.856	4.507688685
-50.000	-0.873	4.404997732
-	-	4.301273037

51.000	0.890	
-52.000	-0.908	4.196567117
-53.000	-0.925	4.090932635
-54.000	-0.943	3.984422356
-55.000	-0.960	3.877089107
-56.000	-0.978	3.768985738
-57.000	-0.995	3.660165076
-58.000	-1.013	3.550679892
-59.000	-1.030	3.440582854
-60.000	-1.048	3.329926492
-61.000	-1.065	3.218763158
-62.000	-1.083	3.107144984
-63.000	-1.100	2.995123849
-64.000	-1.117	2.88275134
-65.000	-1.135	2.770078711
-66.000	-1.152	2.657156851
-67.000	-1.170	2.544036249
-68.000	-1.187	2.430766953
-69.000	-1.205	2.317398543
-70.000	-1.222	2.203980093
-71.000	-1.240	2.09056014
-72.000	-1.257	1.977186652
-73.000	-1.275	1.863906997
-74.000	-1.292	1.750767912

-75.000	-1.310	1.637815476
-76.000	-1.327	1.525095079
-77.000	-1.344	1.412651397
-78.000	-1.362	1.300528365
-79.000	-1.379	1.188769154
-80.000	-1.397	1.077416141
-81.000	-1.414	0.966510893
-82.000	-1.432	0.856094141
-83.000	-1.449	0.746205758
-84.000	-1.467	0.636884745
-85.000	-1.484	0.528169206
-86.000	-1.502	0.420096334
-87.000	-1.519	0.312702392
-88.000	-1.537	0.206022704
-89.000	-1.554	0.100091634
-90.000	-1.571	-0.00

As you can see the net torque is always positive when equal masses attached to the spoke travel on the above curve.

The system has net zero torque at 90 and 180 degrees. It may be one of its singular equilibrium position.

If you have more than one spoke, this singularity will be removed and there can not be any equilibrium state.

That means , the system is basically in inequilrium state and after transiting from several inequilibrim states transiting back to origibal inequilibrium state. It must be a perpetual motion machine.