

# HW 3

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## Chapter 3 Problems

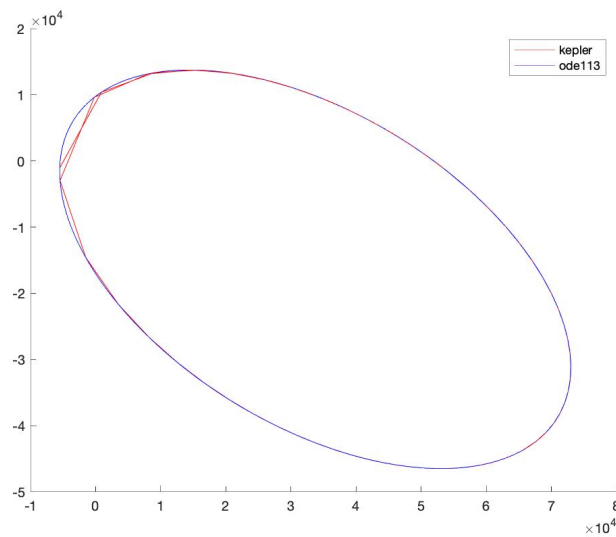


Figure 1: Graphic for input 1

**1**

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Input :

-----  
The gravitational parameter: 398600.00000000  
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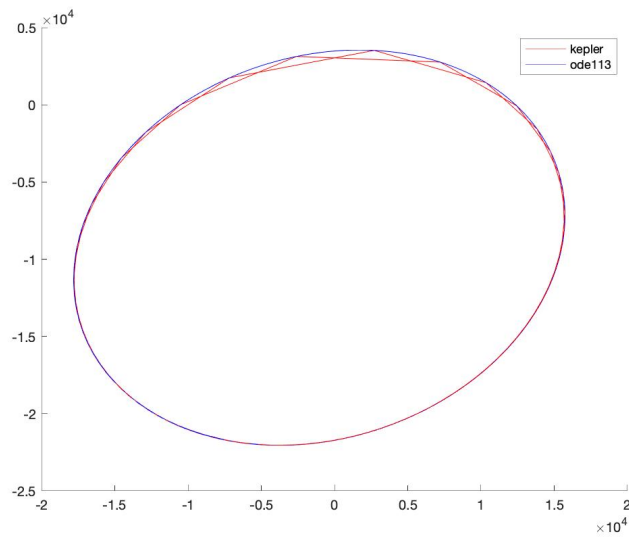


Figure 2: Graphic for input 2

Initial time: 79749.60000000

Final time: 233143.80000000

Initial ECI position:

[ 68524.29800000, -17345.86300000, -51486.40900000]

Initial ECI velocity:

[ -0.57893600, 0.95766500, 0.35775900]

Output:

The Eccentric anomaly: 0.14073604

The true anomaly: 0.52346578

The ECI position using Kepler:

[ -5512.98197119, -1054.51498502, 4375.51370564]

The ECI velocity using Kepler:

[ -0.29208262, -10.13773689, 1.19176170]

The ECI position using ode113:

[ -5512.98197119, -1054.51498502, 4375.51370564]

The ECI velocity using ode113:

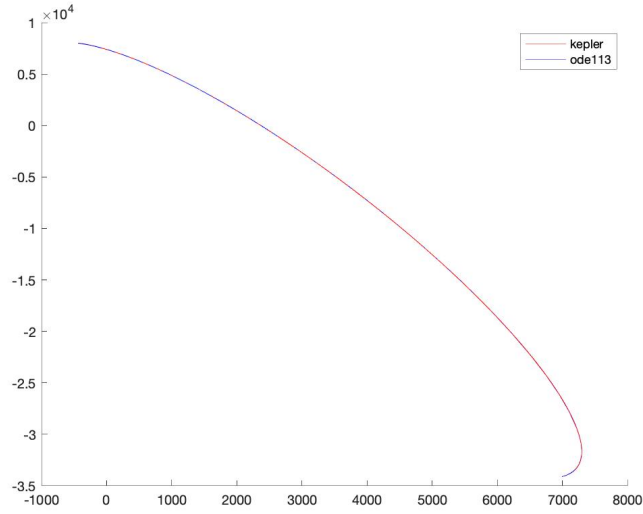


Figure 3: Graphic for input 3

[ -0.29208262, -10.13773689, 1.19176170]

-----  
rPCIf array (Kepler) :

[ 67577.70228506,	66529.65296934,	65376.35408490]
[ 64113.51776486,	62736.28569483,	61239.13205442]
[ 59615.74239779,	57858.86081424,	55960.09462010]
[ 53909.66120723,	51696.05458470,	49305.59799740]
[ 46721.83093247,	43924.64853897,	40889.05874976]
[ 37583.32643071,	33966.09014707,	29981.66417232]
[ 25551.92999188,	20561.35101504,	14827.22168991]
[ 8040.84420943,	-194.41110287,	-5464.82701553]
[ -1532.64277869,	3477.41192751,	8218.15168307]
[ 12611.94415280,	16690.91781097,	20494.39590970]
[ 24055.90945172,	27402.52319042,	30555.99441486]
[ 33533.96723363,	36350.92007266,	39018.87539213]
[ 41547.92602789,	43946.62769249,	46222.29489245]
[ 48381.22686163,	50428.88226909,	52370.01596496]
[ 54208.78722533,	55948.84632121,	57593.40439530]
[ 59145.29032958,	60606.99735777,	61980.72150402]
[ 63268.39343705,	64471.70496284,	65592.13110133]
[ 66630.94847568,	67589.25057454,	68467.96033979]
[ 69267.84051313,	69989.50222344,	70633.41227022]
[ 71199.89926009,	71689.15822057,	72101.25299727]
[ 72436.11613570,	72693.54689909,	72873.20868006]
[ 72974.62661065,	72997.18502505,	72940.12365293]
[ 72802.53160227,	72583.33889503,	72281.30577877]

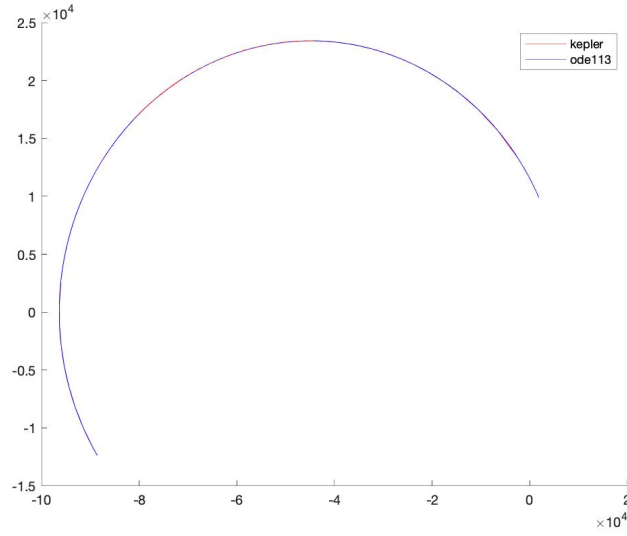


Figure 4: Graphic for input 4

```
[ 71895.00996972, 71422.83165096, 70862.93577440]
[ 70213.25107548, 69471.44511732, 68634.89454727]
[ 67700.64954142, 66665.39112346, 65525.37965532]
[ 64276.39227349, 62913.64632858, 61431.70489137]
[ 59824.35898584, 58084.47919684, 56203.82635651]
[ 54172.80661931, 51980.14952165, 49612.47709532]
[ 47053.71511229, 44284.26918839, 41279.83935771]
[ 38009.65787124, 34433.76598140, 30498.60506258]
[ 26129.46577521, 21216.65846083, 15588.27711557]
[ 8955.51195743, 897.78203503, -5512.70093504]
[-15849.78064811, -14329.91914585, -12787.40650471]
[-11223.49080218, -9639.57567453, -8037.26585754]
[ -6418.42651305, -4785.26174999, -3140.42032561]
[ -1487.14058479, 170.54669305, 1827.52779934]
[ 3477.17901410, 5110.71931824, 6716.19361427]
[ 8276.80565465, 9768.03815252, 11152.34206952]
[ 12368.48465771, 13307.64076452, 13750.49534230]
[ 13156.63424067, 9627.81228694, -2963.23193357]
[-14573.20464889, -21656.22761501, -26667.40587627]
[-30502.36613671, -33562.01141953, -36062.28787777]
[-38134.24064236, -39864.14631958, -41312.25833222]
[-42522.57489863, -43528.36401064, -44355.49402580]
[-45024.54629040, -45552.21215148, -45952.24935141]
[-46236.15626761, -46413.65934256, -46493.07322893]
[-46481.57201525, -46385.39695807, -46210.01798889]
[-45960.26098234, -45640.40926888, -45254.28550253]
```

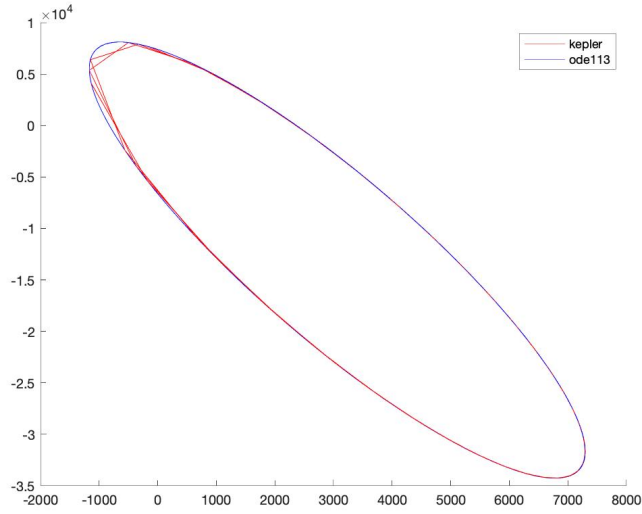


Figure 5: Graphic for input 5

```
[ -44805.31835499, -44296.59735715, -43730.91838999]
[ -43110.82174332, -42438.62424856, -41716.44669384]
[ -40946.23746148, -40129.79298660, -39268.77521490]
[ -38364.72597584, -37419.07846232, -36433.16685404]
[ -35408.23583607, -34345.45138019, -33245.91260020]
[ -32110.66300399, -30940.69943742, -29736.97844488]
[ -28500.42127766, -27231.91913594, -25932.33951040]
[ -24602.53363054, -23243.34470506, -21855.61681532]
[ -20440.20463034, -18997.98432346, -17529.86618449]
[ -16036.80952313, -14519.84061103, -12980.07464261]
[ -11418.74303427, -9837.22787151, -8237.10602605]
[ -6620.20651806, -4988.68628410, -3345.13195061]
[ -1692.69905471, -35.30636948, 1622.08664315]
[ 3273.07333501, 4909.18626651, 6518.93793871]
[ 8086.25706472, 9587.80633646, 10988.08042258]
[ 12229.68841313, 13211.88861304, 13735.41350108]
[ 13324.33365511, 10396.46404330, -1044.71270394]
[ -50894.80915350, -50226.80001787, -49479.33056063]
[ -48648.95686833, -47731.77785559, -46723.35566383]
[ -45618.61608896, -44411.72258383, -43095.91473989]
[ -41663.29817744, -40104.56664738, -38408.62744442]
[ -36562.08538940, -34548.51385047, -32347.39412583]
[ -29932.51757200, -27269.47555745, -24311.51069033]
[ -20992.21476316, -17211.63176889, -12807.19844603]
[ -7488.07593082, -765.95190684, 4519.90949096]
[ 2576.09124175, -634.60731286, -3833.73265004]
```

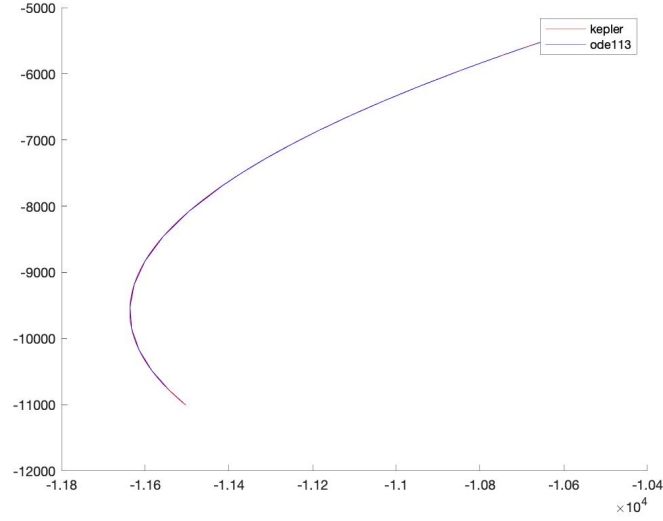


Figure 6: Graphic for input 6

```
[ -6875.80691225, -9747.57260574, -12458.96214754]
[ -15023.50011998, -17453.95940117, -19761.47492458]
[ -21955.53974461, -24044.21372541, -26034.35677771]
[ -27931.83586358, -29741.69634988, -31468.30041793]
[ -33115.43806864, -34686.41619126, -36184.13031350]
[ -37611.12271661, -38969.62978712, -40261.62082581]
[ -41488.83002854, -42652.78296691, -43754.81860101]
[ -44796.10763082, -45777.66781857, -46700.37677692]
[ -47564.98260548, -48372.11266652, -49122.28073599]
[ -49815.89277627, -50453.25164738, -51034.56109277]
[ -51559.92912938, -52029.37053248, -52442.80777823]
[ -52800.07004579, -53100.89065362, -53344.90392357]
[ -53531.64225615, -53660.53331140, -53730.89645134]
[ -53741.93759703, -53692.74216563, -53582.26617825]
[ -53409.32565813, -53172.58421279, -52870.53846304]
[ -52501.50084468, -52063.57921676, -51554.65259580]
[ -50972.34216485, -50313.97646748, -49576.54937330]
[ -48756.66896286, -47850.49487810, -46853.66084521]
[ -45761.17788917, -44567.31204684, -43265.42787111]
[ -41847.78524508, -40305.27122677, -38627.03949540]
[ -36800.01508946, -34808.19708213, -32631.64799215]
[ -30244.97837346, -27614.97967666, -24696.73858708]
[ -21426.85638296, -17710.68079615, -13395.93202617]
[ -8213.33351910, -1686.09326088, 4374.36245043]
vPCIf array (Kepler):
[ -0.64328388, -0.70993738, -0.77919193]
```

[	-0.85138859,	-0.92692459,	-1.00626688]
[	-1.08996985,	-1.17869885,	-1.27326202]
[	-1.37465386,	-1.48411645,	-1.60322722]
[	-1.73402809,	-1.87922138,	-2.04247724]
[	-2.22893623,	-2.44607069,	-2.70524685]
[	-3.02475088,	-3.43608701,	-3.99768113]
[	-4.81586291,	-5.68452064,	0.75361543]
[	3.22270764,	3.17018198,	2.94579367]
[	2.72974320,	2.53967422,	2.37342918]
[	2.22664091,	2.09546846,	1.97689461]
[	1.86859860,	1.76878909,	1.67606766]
[	1.58932773,	1.50768149,	1.43040716]
[	1.35691058,	1.28669687,	1.21934937]
[	1.15451368,	1.09188541,	1.03120072]
[	0.97222894,	0.91476662,	0.85863286]
[	0.80366547,	0.74971785,	0.69665640]
[	0.64435837,	0.59271003,	0.54160511]
[	0.49094350,	0.44063004,	0.39057350]
[	0.34068551,	0.29087962,	0.24107038]
[	0.19117251,	0.14110015,	0.09076627]
[	0.04008195,	-0.01104449,	-0.06270845]
[	-0.11501015,	-0.16805586,	-0.22195918]
[	-0.27684250,	-0.33283867,	-0.39009296]
[	-0.44876540,	-0.50903357,	-0.57109602]
[	-0.63517638,	-0.70152845,	-0.77044260]
[	-0.84225371,	-0.91735137,	-0.99619301]
[	-1.07932103,	-1.16738547,	-1.26117465]
[	-1.36165705,	-1.47003990,	-1.58785300]
[	-1.71707165,	-1.86030233,	-2.02107284]
[	-2.20430394,	-2.41711272,	-2.67025852]
[	-2.98091972,	-3.37842287,	-3.91670514]
[	-4.69610329,	-5.66014245,	-0.29798415]
[	0.97335487,	0.98834910,	1.00257994]
[	1.01595937,	1.02837355,	1.03967528]
[	1.04967356,	1.05811900,	1.06468289]
[	1.06892679,	1.07025704,	1.06785511]
[	1.06056741,	1.04672447,	1.02383146]
[	0.98801008,	0.93292650,	0.84756266]
[	0.71108493,	0.47929563,	0.04121349]
[	-0.96748169,	-4.38081792,	-9.76207295]
[	-5.62166180,	-3.75940654,	-2.79570140]
[	-2.19493908,	-1.77673860,	-1.46430805]
[	-1.21924647,	-1.02008431,	-0.85380313]
[	-0.71200782,	-0.58901723,	-0.48083477]
[	-0.38455788,	-0.29802172,	-0.21957476]
[	-0.14793242,	-0.08207861,	-0.02119767]
[	0.03537372,	0.08818125,	0.13767850]
[	0.18424597,	0.22820557,	0.26983166]
[	0.30935968,	0.34699296,	0.38290802]
[	0.41725893,	0.45018075,	0.48179231]

[	0.51219856,	0.54149242,	0.56975634]
[	0.59706364,	0.62347963,	0.64906250]
[	0.67386407,	0.69793030,	0.72130170]
[	0.74401366,	0.76609669,	0.78757663]
[	0.80847484,	0.82880812,	0.84858868]
[	0.86782385,	0.88651570,	0.90466051]
[	0.92224805,	0.93926057,	0.95567152]
[	0.97144385,	0.98652775,	1.00085768]
[	1.01434841,	1.02688964,	1.03833883]
[	1.04851112,	1.05716532,	1.06398402]
[	1.06854447,	1.07027547,	1.06839137]
[	1.06178812,	1.04887373,	1.02727941]
[	0.99334251,	0.94112182,	0.86037253]
[	0.73194983,	0.51590738,	0.11442013]
[	-0.78066668,	-3.63594954,	-10.13885676]
[	0.40616443,	0.45642402,	0.50877331]
[	0.56348515,	0.62087844,	0.68132928]
[	0.74528577,	0.81328762,	0.88599279]
[	0.96421423,	1.04897165,	1.14156623]
[	1.24369124,	1.35760117,	1.48637965]
[	1.63438225,	1.80800655,	2.01711572]
[	2.27787368,	2.61891901,	3.09612584]
[	3.82663747,	4.82524874,	0.34509378]
[	-1.96382198,	-2.10040460,	-2.01815899]
[	-1.90782152,	-1.80024913,	-1.70108042]
[	-1.61058518,	-1.52782912,	-1.45171203]
[	-1.38123360,	-1.31554564,	-1.25394426]
[	-1.19584772,	-1.14077368,	-1.08831969]
[	-1.03814729,	-0.98996948,	-0.94354082]
[	-0.89864964,	-0.85511185,	-0.81276605]
[	-0.77146958,	-0.73109534,	-0.69152916]
[	-0.65266769,	-0.61441660,	-0.57668911]
[	-0.53940469,	-0.50248800,	-0.46586797]
[	-0.42947694,	-0.39324997,	-0.35712417]
[	-0.32103798,	-0.28493060,	-0.24874130]
[	-0.21240886,	-0.17587111,	-0.13906441]
[	-0.10192315,	-0.06437917,	-0.02636094]
[	0.01220723,	0.05140613,	0.09132271]
[	0.13205117,	0.17369433,	0.21636520]
[	0.26018886,	0.30530469,	0.35186920]
[	0.40005933,	0.45007663,	0.50215252]
[	0.55655479,	0.61359606,	0.67364463]
[	0.73713870,	0.80460532,	0.87668603]
[	0.95417210,	1.03805406,	1.12959304]
[	1.23042593,	1.34272553,	1.46945305]
[	1.61477311,	1.78477043,	1.98876391]
[	2.24189763,	2.57071668,	3.02636168]
[	3.71598088,	4.73542188,	1.19644474]



## 2

```
-----
-----

Input:
-----
The gravitational parameter: 398600.00000000
-----
Initial time: 235.80000000
-----
Final time: 106294.80000000
-----
Initial ECI position:
[ 2721.96500000, 3522.86300000, 5267.24400000]
-----
Initial ECI velocity:
[ 9.57239600, -0.47470100, -2.72566400]
-----
Output:
-----
The Eccentric anomaly: 4.32372125
-----
The true anomaly: 3.66519758
-----
The ECI position using Kepler:
[ -17050.20495277, -15005.91785347, -21329.68290266]
-----
The ECI velocity using Kepler:
[ -0.64888650, 1.48251638, 2.58054034]
-----
The ECI position using ode113:
[ -17050.20495277, -15005.91785347, -21329.68290266]
-----
The ECI velocity using ode113:
[ -0.64888650, 1.48251638, 2.58054034]
-----
rPCI array (Kepler) :
[ 10354.92722122, 13838.19236396, 15313.12960197]
[ 15733.22777814, 15517.02778384, 14880.07495311]
[ 13947.71493286, 12799.59035951, 11489.82463829]
[ 10057.22471682, 8530.89298047, 6933.53134803]
[ 5283.50208375, 3596.18153936, 1884.89055721]
[ 161.55729023, -1562.78489782, -3277.57858599]
```

[ -4972.34766705, -6636.31557686, -8258.02824219]  
 [ -9824.93655707, -11322.87059068, -12735.33643581]  
 [ -14042.54348299, -15220.00111241, -16236.39663169]  
 [ -17050.22442140, -17604.12901106, -17814.77074848]  
 [ -17553.13959263, -16602.16322196, -14552.67075344]  
 [ -10511.90407636, -2585.47098537, 7215.38282258]  
 [ 12445.67984722, 14747.08500170, 15621.73175156]  
 [ 15688.38928673, 15242.22371854, 14445.55807561]  
 [ 13397.38346417, 12162.88253858, 10787.61567509]  
 [ 9305.01947781, 7740.68086816, 6114.92953718]  
 [ 4444.49827729, 2743.63988795, 1024.90920034]  
 [ -700.26805628, -2421.14637677, -4127.25755506]  
 [ -5808.02227548, -7452.37372296, -9048.36821411]  
 [ -10582.72218437, -12040.20691154, -13402.82541159]  
 [ -14648.65100946, -15750.11232263, -16671.33641464]  
 [ -17363.81539968, -17758.90497541, -17753.86364890]  
 [ -17183.39271623, -15754.44266980, -12874.23413137]  
 [ -7176.40348356, 2711.25966123, 10349.60833044]  
 [ 13835.84949831, 15312.24124654, 15733.17026501]  
 [ 15517.50021632, 14880.91062148, 13948.81170256]  
 [ 12800.88077848, 11491.26146517, 10058.77323208]  
 [ 8532.52658783, 6935.22889935, 5285.24616227]  
 [ 3597.95730258, 1886.68492570, 163.35835782]  
 [ -1560.98832904, -3275.79742497, -4970.59293937]  
 [ -6634.59881658, -8256.36189535, -9823.33446201]  
 [ -11321.34860666, -12733.91329712, -14041.24200209]  
 [ -15218.84995385, -16235.43305490, -17049.49874304]  
 [ 1426.99737855, -1577.66241646, -4414.16127240]  
 [ -6964.18916169, -9239.88502703, -11268.84750040]  
 [ -13076.39719994, -14683.20771239, -16105.71538389]  
 [ -17356.91599624, -18447.06989545, -19384.24730193]  
 [ -20174.73256890, -20823.31889311, -21333.52181469]  
 [ -21707.73089798, -21947.30695117, -22052.62908805]  
 [ -22023.10400037, -21857.14825514, -21552.13752305]  
 [ -21104.30746113, -20508.59595071, -19758.41620907]  
 [ -18845.33801137, -17758.63776517, -16484.65742275]  
 [ -15005.87962368, -13299.57685211, -11335.83476163]  
 [ -9074.78110826, -6463.62080962, -3440.10198171]  
 [ 0.68240614, 3134.29379794, 2764.84949672]  
 [ -71.99419959, -3028.92968981, -5723.73027707]  
 [ -8133.45374971, -10282.47776236, -12197.97049377]  
 [ -13902.95261087, -15415.88514110, -16751.38835060]  
 [ -17921.01359876, -18933.86867019, -19797.08881114]  
 [ -20516.18238680, -21095.28190480, -21537.32499569]  
 [ -21844.17853360, -22016.70983851, -22054.81292502]  
 [ -21957.40386228, -21722.38834218, -21346.58849592]  
 [ -20825.61544918, -20153.67891560, -19323.31825440]  
 [ -18325.02420668, -17146.70266126, -15772.90608503]  
 [ -14183.71741587, -12353.11431897, -10246.60277590]  
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### 3

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Initial time: 14569.20000000
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Final time: 36761.40000000
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Initial ECI velocity:
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Output:
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The true anomaly: 4.88688283
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[	-5.44884319,	-5.83070811,	-6.24935346]
[	-6.70656073,	-7.20050981,	-7.72126815]
-----			
-----			
-----			
-----			

4

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-----

```

Input:
-----
The gravitational parameter: 398600.00000000
-----
Initial time: 37007.40000000
-----
Final time: 112824.60000000
-----
Initial ECI position:
[ 1882.72500000, 9864.69000000, 4086.08800000]
-----
Initial ECI velocity:
[ -5.56536700, 5.45154800, 2.25810500]
-----
Output:
-----
The Eccentric anomaly: 3.69968249
-----
The true anomaly: 3.29208728
-----
The ECI position using Kepler:
[ -88561.01573285, -12407.23697960, -5139.24408806]
-----
The ECI velocity using Kepler:
[ 0.84727152, -0.61711225, -0.25561625]
-----
The ECI position using ode113:
[ -88561.01573285, -12407.23697960, -5139.24408806]
-----
The ECI velocity using ode113:
[ 0.84727152, -0.61711225, -0.25561625]
-----
rPCI array (Kepler) :
[ -2424.03743323, -6581.23618623, -10489.81049050]
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[	-0.25974153,	-0.25773947,	-0.25561804]

-----  
-----  
-----  
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## 5

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-----  
-----  
-----

Input:

-----  
The gravitational parameter: 398600.00000000  
-----

Initial time: 1261.20000000  
-----

```

Final time: 114802.80000000
-----
Initial ECI position:
[ -664.69900000, 8112.75000000, 4479.81000000]
-----
Initial ECI velocity:
[ -0.87036000, -0.06804600, -8.29045900]
-----
Output:
-----
The Eccentric anomaly: 5.52315893
-----
The true anomaly: 4.71200515
-----
The ECI position using Kepler:
[ -152.20055604, 7659.29279410, 8708.02304154]
-----
The ECI velocity using Kepler:
[ -0.95797900, 1.51904916, -7.01444094]
-----
The ECI position using ode113:
[ -152.20055604, 7659.29279410, 8708.02304154]
-----
The ECI velocity using ode113:
[ -0.95797900, 1.51904916, -7.01444094]
-----
rPCIf array (Kepler) :
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[ 6880.92810445, 7065.25222713, 7195.24068085]
[ 7272.43555811, 7297.88074837, 7272.16573990]
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