

Formatting: The answers to the questions are presented first and then the logs for the runs will be put as the end.

Q1a)

The number of steps = 976089

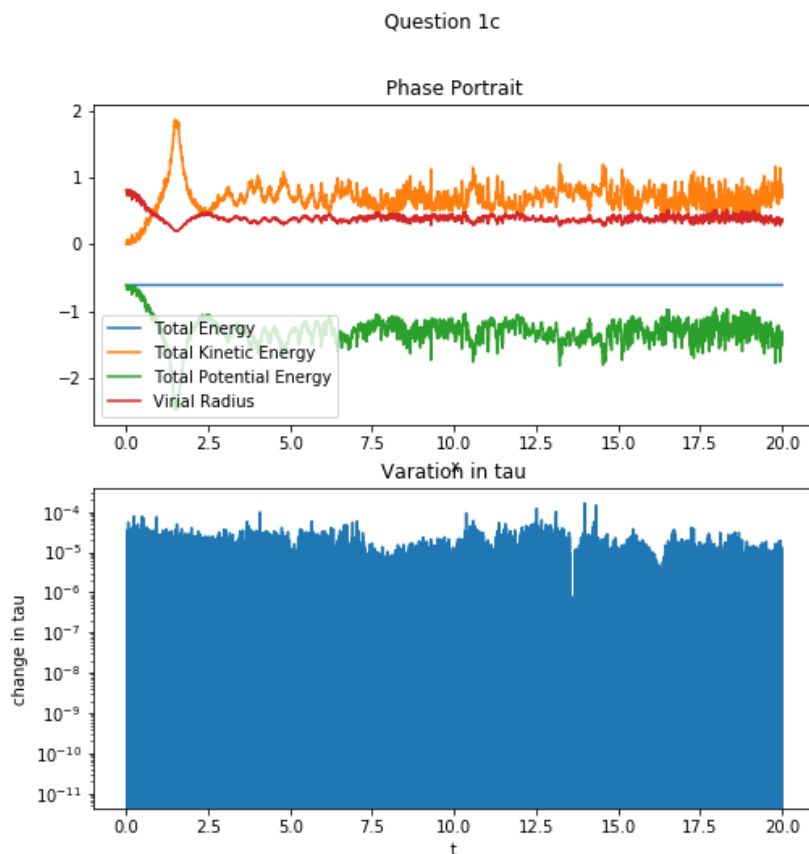
$\eta = .5$

Q1b)

The total number of steps is 1066360.

Discussion: The number of bound particles varies within a 40-70 range for each time step, so in order to save space the entire log is not pasted. It is not understood why the number of bound particles is so high. Different initialization methods were used but the number of bound particles remained the same. The relative energy used was found by calculating the potential and kinetic energy of the particles and summing them. The orbital energy is found through the orbital elements function.

Q1c)



Q1d)

The total number of steps was 400,000 with a time step of .00005

Q2)

The total number of steps was 9360 with a $dE_{tot} = 10e-8$

Q3)

The total number of steps is 309569 with a $dE_{tot} = 5e-8$. The total number of steps was found to be about 3 times as less as Q1a and Q1b.

LOGS:

Q1

a)

Initial E = -0.5285209525685945
t = 0.0 dE = 0.0 steps = 0
semimajor axis = 1.9686327737874272 eccentricity = 0.6027562517609921
Energy error is = 5.968715521831314e-10 at t = 0.0007963942009361405
dt = 0.0003970521422272606
Energy error is = 1.5608137116096543e-08 at t = 0.5000184333082136
dt = 9.462761955580186e-05
Energy error is = 4.6573639744806883e-07 at t = 1.0000046648562642
dt = 9.132465531509402e-06
Energy error is = 4.4328050585740186e-07 at t = 1.500038834935594
dt = 6.0458456705641603e-05
Energy error is = 6.284593883076894e-07 at t = 2.0000307786664204
dt = 3.6958435458385104e-05
Energy error is = 3.8796911328020656e-07 at t = 2.5000505874165126
dt = 6.979260644985482e-05
Energy error is = 1.137418280894309e-06 at t = 3.0000085707920046
dt = 4.380076036167323e-05
Energy error is = 1.2776363096378418e-06 at t = 3.5000340903859213
dt = 3.659921252850799e-05
Energy error is = 1.2758924327060939e-06 at t = 4.0000064968312135
dt = 3.29195437197466e-05
Energy error is = 8.462133891384838e-07 at t = 4.5000060311511785
dt = 2.026937200059831e-05
Energy error is = 1.3823649551714112e-06 at t = 5.000002146544809
dt = 1.7034854163109932e-05
Energy error is = 1.9888169803250477e-06 at t = 5.500002809956609
dt = 2.779509656818491e-05
Energy error is = 1.957987180389864e-06 at t = 6.000011735916923
dt = 6.126697479156061e-05
Energy error is = 1.408496461130504e-06 at t = 6.500001079513511
dt = 1.2964341215922555e-05
Energy error is = 2.0258991351163047e-07 at t = 7.000002639278296
dt = 1.2015157795305747e-05
Energy error is = 2.6992123036695403e-07 at t = 7.50000884687245
dt = 1.7127821394806945e-05
Energy error is = 5.517727021953078e-07 at t = 8.000018608745687
dt = 2.4650085554613405e-05
Energy error is = 1.0414736012487325e-06 at t = 8.500021334167455
dt = 3.084061795173974e-05
Energy error is = 8.289716023623939e-07 at t = 9.000021619937018
dt = 2.6842944809328862e-05
Energy error is = 1.2873608631336353e-06 at t = 9.50000923038856
dt = 1.0901533077739855e-05
Energy error is = 6.253228981289993e-07 at t = 10.000008171044437
dt = 2.847361853719038e-05
Energy error is = 1.173269831289403e-07 at t = 10.500008811425062
dt = 1.8779736467457678e-05
Energy error is = 1.4499501388431923e-07 at t = 11.000011602810645
dt = 2.304497810410908e-05
Energy error is = 9.240795713072458e-07 at t = 11.500004052209784
dt = 1.993601528964536e-05
Energy error is = 9.145448398584222e-08 at t = 12.000003463958837

dt = 1.3763857610333157e-05
 Energy error is = 4.057337470442235e-07 at t = 12.500009125784578
 dt = 9.615477971877496e-06
 Energy error is = 5.734663418577313e-07 at t = 13.000012252155894
 dt = 1.3247876231763161e-05
 Energy error is = 1.2132834358302702e-06 at t = 13.500000166695173
 dt = 8.924519070942842e-06
 Energy error is = 7.108697990254598e-07 at t = 14.000028913338792
 dt = 5.479707535732612e-05
 Energy error is = 5.876958458772563e-07 at t = 14.500000084041663
 dt = 1.8139069628560774e-05
 Energy error is = 1.898937018740554e-06 at t = 15.000007730787607
 dt = 9.086547564791653e-06
 Energy error is = 2.4697555983665964e-06 at t = 15.500006440430528
 dt = 1.2651549788311478e-05
 Energy error is = 1.8550595928257252e-06 at t = 16.000006736401684
 dt = 1.2890934774740459e-05
 Energy error is = 2.6547383007446967e-06 at t = 16.500006170956933
 dt = 1.2308214089495123e-05
 Energy error is = 1.960495839226084e-06 at t = 17.00000500221348
 dt = 9.632135377649903e-06
 Energy error is = 6.05144096166299e-07 at t = 17.500012979964342
 dt = 1.550664312607807e-05
 Energy error is = 1.4418798960358359e-06 at t = 18.00000585805589
 dt = 1.0138990069671221e-05
 Energy error is = 3.19724651642872e-06 at t = 18.500017612300567
 dt = 1.8986435306264553e-05
 Energy error is = 2.7276775870221925e-06 at t = 19.000005738681253
 dt = 1.7742059961488554e-05
 Energy error is = 2.941640568687731e-06 at t = 19.500002010967105
 dt = 1.6633892485442586e-05
 dt = 1.4130254715455657e-05

b)

Initial E = -0.6064129818365092
 t = 0.0 dE = 0.0 steps = 0

Time = 0.00021076121580155898, Energy Error = 1.6846857242569513e-11

Bound Particles 1 and 19 with orbital energy = -0.013329361512882575 and period = 57.740540630068516
 Bound Particles 1 and 35 with orbital energy = -0.02188539968009421 and period = 27.444994163723273
 Bound Particles 2 and 26 with orbital energy = -0.056695692449767125 and period = 6.582180238933649
 Bound Particles 3 and 16 with orbital energy = -0.026701557151752636 and period = 20.365261123334335
 Bound Particles 3 and 47 with orbital energy = -0.020309064870915293 and period = 30.70152696293065
 Bound Particles 4 and 19 with orbital energy = -0.038048481720375414 and period = 11.972610913855394
 Bound Particles 4 and 27 with orbital energy = -0.07082951557696977 and period = 4.713825037952042
 Bound Particles 5 and 22 with orbital energy = -0.06906681231449055 and period = 4.895428906053877
 Bound Particles 5 and 38 with orbital energy = -0.023098308185564957 and period = 25.311892004073812
 Bound Particles 6 and 13 with orbital energy = -0.03319150378679636 and period = 14.694488470076951
 Bound Particles 6 and 35 with orbital energy = -0.08808553199021399 and period = 3.3988969206154263
 Bound Particles 6 and 43 with orbital energy = -0.02060918960281364 and period = 30.03333041729742
 Bound Particles 7 and 29 with orbital energy = -0.06612779575708178 and period = 5.225391040967403
 Bound Particles 7 and 37 with orbital energy = -0.16639415620401854 and period = 1.309145030887635

Bound Particles 7 and 47 with orbital energy = -0.0191747216864884 and period = 33.46580395579555
 Bound Particles 8 and 11 with orbital energy = -0.044634475852497815 and period = 9.42300035395113
 Bound Particles 8 and 28 with orbital energy = -0.018862046384492653 and period = 34.30138479095269
 Bound Particles 8 and 30 with orbital energy = -0.030897525922532653 and period = 16.36097979375537
 Bound Particles 9 and 10 with orbital energy = -0.07213458016059413 and period = 4.586481050550532
 Bound Particles 9 and 13 with orbital energy = -0.04337543885224467 and period = 9.8362383394976
 Bound Particles 9 and 18 with orbital energy = -0.04636560161358519 and period = 8.900225642672169
 Bound Particles 9 and 44 with orbital energy = -0.031241795427240305 and period = 16.091291034486627
 Bound Particles 10 and 13 with orbital energy = -0.08121122366882864 and period = 3.8394656334747372
 Bound Particles 10 and 18 with orbital energy = -0.05121669478365222 and period = 7.666154079577555
 Bound Particles 11 and 28 with orbital energy = -0.06539809766166411 and period = 5.313090248758912
 Bound Particles 11 and 30 with orbital energy = -0.16591979462991763 and period = 1.3147632732767771
 Bound Particles 12 and 20 with orbital energy = -0.020910650702143586 and period = 29.38620777473291
 Bound Particles 12 and 42 with orbital energy = -0.021895612955188708 and period = 27.425793701992784
 Bound Particles 13 and 35 with orbital energy = -0.018448200368719955 and period = 35.46205147072467
 Bound Particles 13 and 43 with orbital energy = -0.13191543914631862 and period = 1.8546049937444884
 Bound Particles 14 and 21 with orbital energy = -0.1361271606398199 and period = 1.7692030815393562
 Bound Particles 14 and 25 with orbital energy = -0.05973964859989513 and period = 6.085564512256481
 Bound Particles 15 and 49 with orbital energy = -0.07844763058327378 and period = 4.044130114828624
 Bound Particles 16 and 20 with orbital energy = -0.020525764315281185 and period = 30.216618358846567
 Bound Particles 16 and 37 with orbital energy = -0.017457580187796858 and period = 38.52288443477172
 Bound Particles 16 and 47 with orbital energy = -0.08203642126403107 and period = 3.7816802579844304
 Bound Particles 17 and 34 with orbital energy = -0.16436336662230133 and period = 1.3334825099206487
 Bound Particles 20 and 37 with orbital energy = -0.3499818643940725 and period = 0.4291672325665269
 Bound Particles 20 and 42 with orbital energy = -0.8645116567707386 and period = 0.11054486811837279
 Bound Particles 21 and 25 with orbital energy = -0.04828154890422952 and period = 8.375737831046083
 Bound Particles 22 and 38 with orbital energy = -0.021199984619932957 and period = 28.786677832777062
 Bound Particles 23 and 24 with orbital energy = -0.06359829142349495 and period = 5.540215953703048
 Bound Particles 23 and 31 with orbital energy = -0.04860457301904147 and period = 8.292379469825239
 Bound Particles 23 and 39 with orbital energy = -0.05942665498826981 and period = 6.133705753825193
 Bound Particles 24 and 39 with orbital energy = -0.09515986231016238 and period = 3.0270121121983196
 Bound Particles 24 and 41 with orbital energy = -0.09457246973411379 and period = 3.055257157533881
 Bound Particles 25 and 33 with orbital energy = -0.10429453413566803 and period = 2.638168578222138
 Bound Particles 25 and 45 with orbital energy = -0.07656671199926762 and period = 4.194062227065974
 Bound Particles 26 and 29 with orbital energy = -0.2539646216401445 and period = 0.6942806055163057
 Bound Particles 26 and 31 with orbital energy = -0.04263776887877303 and period = 10.092602284034546
 Bound Particles 28 and 30 with orbital energy = -0.0979808505845321 and period = 2.897230564948392
 Bound Particles 29 and 37 with orbital energy = -0.11546893481686048 and period = 2.264629325709409
 Bound Particles 33 and 45 with orbital energy = -0.06922209633854912 and period = 4.878965476233804
 Bound Particles 35 and 43 with orbital energy = -0.011833603173252038 and period = 69.02705800885929
 Bound Particles 37 and 47 with orbital energy = -0.01919217935688949 and period = 33.420152384476395
 Bound Particles 39 and 41 with orbital energy = -1.5328926307589428 and period = 0.0468195528445005
 Bound Particles 44 and 46 with orbital energy = -0.09164516979586518 and period = 3.2028049857714715
 Number of Bound Particles = 57

Time = 0.5000629589342604, Energy Error = 3.576380379621824e-07

Bound Particles 1 and 10 with orbital energy = 0.18452929090320624 and period = 1.1209775032581488
 Bound Particles 1 and 19 with orbital energy = 0.020825547070616384 and period = 29.566521853003515
 Bound Particles 1 and 27 with orbital energy = -0.09413460840854157 and period = 3.0765989374080234
 Bound Particles 2 and 7 with orbital energy = -0.06197877433983609 and period = 5.75877871491179
 Bound Particles 2 and 29 with orbital energy = 0.13108673286377845 and period = 1.8722194684408364
 Bound Particles 3 and 7 with orbital energy = 1.1982514284227377 and period = 0.06774432706946167
 Bound Particles 3 and 20 with orbital energy = 0.45152942099615156 and period = 0.2928638624843009
 Bound Particles 4 and 6 with orbital energy = 0.06398571934965336 and period = 5.489973915444269
 Bound Particles 4 and 10 with orbital energy = -0.1560181444919224 and period = 1.4418902860968552
 Bound Particles 4 and 19 with orbital energy = -0.010825021836285247 and period = 78.8954022119269
 Bound Particles 4 and 35 with orbital energy = 0.04266894664586025 and period = 10.081542461595221

Bound Particles 6 and 35 with orbital energy = -0.07520541541441311 and period = 4.308451360316986
 Bound Particles 7 and 20 with orbital energy = -0.04043817618166734 and period = 10.927165631965995
 Bound Particles 8 and 28 with orbital energy = 0.14201711333307038 and period = 1.6602895900979238
 Bound Particles 9 and 43 with orbital energy = 0.34935145929588907 and period = 0.43032940558350097
 Bound Particles 10 and 19 with orbital energy = 0.4396681451026737 and period = 0.3047946673679054
 Bound Particles 11 and 13 with orbital energy = -0.21166881614424402 and period = 0.9124509863078406
 Bound Particles 11 and 30 with orbital energy = 0.1203068803220482 and period = 2.129409407085169
 Bound Particles 11 and 44 with orbital energy = -0.053208707217813456 and period = 7.2397039196104265
 Bound Particles 11 and 46 with orbital energy = 0.3289122858179747 and period = 0.47105836710811705
 Bound Particles 12 and 15 with orbital energy = -0.42605159889090116 and period = 0.3195225893532346
 Bound Particles 13 and 30 with orbital energy = 0.011183519817532739 and period = 75.13237174831607
 Bound Particles 13 and 44 with orbital energy = 0.9814538701491572 and period = 0.0913881799828322
 Bound Particles 13 and 46 with orbital energy = 0.05913231101143557 and period = 6.1795604862911215
 Bound Particles 14 and 21 with orbital energy = -0.114408713895918 and period = 2.2961814853576614
 Bound Particles 16 and 20 with orbital energy = 0.11468642600649223 and period = 2.287846263304695
 Bound Particles 16 and 26 with orbital energy = 0.06662864323190905 and period = 5.1665830109916575
 Bound Particles 16 and 37 with orbital energy = 0.41981890410202366 and period = 0.32666445474419636
 Bound Particles 16 and 42 with orbital energy = 0.025299075418850084 and period = 22.081973868688095
 Bound Particles 16 and 47 with orbital energy = 0.2759032202181376 and period = 0.6131400883184507
 Bound Particles 20 and 26 with orbital energy = -0.04829357032076312 and period = 8.372610645592882
 Bound Particles 20 and 37 with orbital energy = -0.29652509151367157 and period = 0.5503040300197471
 Bound Particles 20 and 42 with orbital energy = -0.4707045491472345 and period = 0.27515174587257885
 Bound Particles 21 and 25 with orbital energy = -0.006340633677675768 and period = 175.99319336931055
 Bound Particles 22 and 33 with orbital energy = 0.08155692148017515 and period = 3.8150798302411584
 Bound Particles 22 and 38 with orbital energy = 0.043439295785669525 and period = 9.81455700995038
 Bound Particles 23 and 24 with orbital energy = -0.04031953990636775 and period = 10.97542925430561
 Bound Particles 23 and 31 with orbital energy = 0.06100963489296404 and period = 5.896539704087064
 Bound Particles 23 and 39 with orbital energy = -0.025801353680018117 and period = 21.440313343997335
 Bound Particles 24 and 31 with orbital energy = -0.18599322023928472 and period = 1.1077689692659947
 Bound Particles 24 and 39 with orbital energy = 0.01693523593271816 and period = 40.31883632745573
 Bound Particles 24 and 41 with orbital energy = -0.014856253646627099 and period = 49.071677864077
 Bound Particles 26 and 37 with orbital energy = 0.2561005985357343 and period = 0.685612893098645
 Bound Particles 26 and 42 with orbital energy = -0.029882771127184682 and period = 17.201390824115173
 Bound Particles 26 and 47 with orbital energy = 0.7272645524640408 and period = 0.14327032165491554
 Bound Particles 30 and 44 with orbital energy = 0.8176049862525829 and period = 0.12019310900423291
 Bound Particles 30 and 46 with orbital energy = 0.04992743507646302 and period = 7.965003716524235
 Bound Particles 32 and 49 with orbital energy = 0.1959768405687598 and period = 1.0242069966411305
 Bound Particles 37 and 42 with orbital energy = -0.4643152167983877 and period = 0.28085068723896156
 Bound Particles 37 and 47 with orbital energy = 0.4571001462062997 and period = 0.28752646562994766
 Bound Particles 39 and 41 with orbital energy = -1.5328181089015982 and period = 0.04682296726375713
 Bound Particles 40 and 45 with orbital energy = 0.032213457847169544 and period = 15.368760696538377
 Bound Particles 42 and 47 with orbital energy = 0.44704174422196086 and period = 0.2972848296113182
 Bound Particles 44 and 46 with orbital energy = 1.0779522435997064 and period = 0.07939544460045762
 Number of Bound Particles = 54

D)

Q1d:

Initial E = -0.6321712571999737

t = 0.0 dE = 0.0 steps = 0

semimajor axis = 0.19761059146559856 eccentricity = 0.8092791917638121

Energy error is = 2.5413005033669833e-13 at t = 5e-05

dt = 5e-05

Energy error is = 8.083060409891374e-08 at t = 0.5000499999999531

dt = 5e-05

Energy error is = 3.0996588040732576e-07 at t = 1.00004999999998982

dt = 5e-05
Energy error is = 7.074562702324982e-08 at t = 1.5000000000009532
dt = 5e-05
Energy error is = 1.3152942401895018e-08 at t = 2.000000000002008
dt = 5e-05
Energy error is = 9.810761092410303e-10 at t = 2.500000000000843
dt = 5e-05
Energy error is = 4.8843795008579605e-08 at t = 3.0000499999996775
dt = 5e-05
Energy error is = 4.70580311384694e-08 at t = 3.500049999998512
dt = 5e-05
Energy error is = 2.3638690305194388e-07 at t = 4.000049999997347
dt = 5e-05
Energy error is = 7.017259773256512e-09 at t = 4.500049999996182
dt = 5e-05
Energy error is = 4.931824215681502e-08 at t = 5.000049999995016
dt = 5e-05
Energy error is = 1.4885023880140125e-08 at t = 5.500049999993851
dt = 5e-05
Energy error is = 3.794314085148187e-09 at t = 6.000049999992686
dt = 5e-05
Energy error is = 4.688992372159362e-08 at t = 6.5000499999915204
dt = 5e-05
Energy error is = 3.712182896631333e-07 at t = 7.000049999990355
dt = 5e-05
Energy error is = 1.1335679539481447e-07 at t = 7.50004999998919
dt = 5e-05
Energy error is = 2.999045578544468e-08 at t = 8.000049999988025
dt = 5e-05
Energy error is = 5.343292075465911e-08 at t = 8.50004999998686
dt = 5e-05
Energy error is = 1.446468667065659e-07 at t = 9.000049999985695
dt = 5e-05
Energy error is = 1.1541590261288093e-07 at t = 9.50004999998453
dt = 5e-05
Energy error is = 4.0298046377618135e-07 at t = 10.000049999983364
dt = 5e-05
Energy error is = 1.1529626031681062e-07 at t = 10.500049999982199
dt = 5e-05
Energy error is = 1.7452935187067808e-06 at t = 11.000049999981034
dt = 5e-05
Energy error is = 1.4813359217047406e-07 at t = 11.500049999979868
dt = 5e-05
Energy error is = 1.320550931160902e-06 at t = 12.000049999978703
dt = 5e-05
Energy error is = 5.603276174159788e-07 at t = 12.500049999977538
dt = 5e-05
Energy error is = 1.6170184236052876e-07 at t = 13.000049999976373
dt = 5e-05
Energy error is = 2.703753143595833e-07 at t = 13.500049999975207
dt = 5e-05
Energy error is = 2.5839379252934336e-06 at t = 14.000049999974042
dt = 5e-05
Energy error is = 6.795142248883224e-08 at t = 14.500049999972877
dt = 5e-05
Energy error is = 1.2970814844415202e-07 at t = 15.000049999971711
dt = 5e-05
Energy error is = 1.6140267489195281e-06 at t = 15.500049999970546

dt = 5e-05
 Energy error is = 9.617849558773983e-06 at t = 16.00004999996938
 dt = 5e-05
 Energy error is = 2.865736703494548e-08 at t = 16.50004999998598
 dt = 5e-05
 Energy error is = 3.5948572785216015e-07 at t = 17.00000000002576
 dt = 5e-05
 Energy error is = 2.6471840020025894e-07 at t = 17.500000000019174
 dt = 5e-05
 Energy error is = 5.57381966581616e-07 at t = 18.000000000035772
 dt = 5e-05
 Energy error is = 1.8395341339072502e-07 at t = 18.50000000005237
 dt = 5e-05
 Energy error is = 6.346548464541968e-08 at t = 19.00000000006897
 dt = 5e-05
 Energy error is = 1.8754095143513894e-07 at t = 19.500000000085567
 dt = 5e-05
 Energy error is = 2.2498023799499833e-06 at t = 20.000000000102165
 dt = 5e-05
 dt = 5e-05

The number of steps = 400000

Q2)

Initial E = -0.12095
 t = 0.0 dE = 0.0 steps = 0
 semimajor axis = 1.0334849111202977 eccentricity = 0.9352
 Energy error is = 1.649159975247727e-11 at t = 0.02
 dt = 0.015
 Energy error is = 5.296700454349157e-07 at t = 1.0176824127081818
 dt = 0.02349307639159917
 Energy error is = 1.6440152285912557e-06 at t = 2.0214002537969367
 dt = 0.01079314175584533
 Energy error is = 5.334473701712472e-06 at t = 3.0015821016078643
 dt = 0.0016960729310715231
 Energy error is = 3.036399829348113e-06 at t = 4.000115980385609
 dt = 0.0049009533208899374
 Energy error is = 1.2467082627642956e-06 at t = 5.005104520210392
 dt = 0.015307191571629719
 Energy error is = 5.114795288002627e-07 at t = 6.009878740291028
 dt = 0.030149146779080798
 Energy error is = 5.76959544432154e-07 at t = 7.062397316653546
 dt = 0.0353430342833685
 Energy error is = 1.2818125572078287e-06 at t = 8.00968786521922
 dt = 0.018029483679148976
 Energy error is = 2.8497384778752854e-06 at t = 9.011475059734224
 dt = 0.006788248929822984
 Energy error is = 9.494177745206223e-06 at t = 10.00045283442677
 dt = 0.00042087231870666846
 Energy error is = 2.6239371648389964e-06 at t = 11.005786818270927
 dt = 0.008748131206552427
 Energy error is = 1.4396492952761797e-06 at t = 12.024273664543145

dt = 0.020546926081957507
Energy error is = 9.111601568245753e-07 at t = 13.019323874405178
dt = 0.04454719979809447
Energy error is = 1.3631201197100706e-06 at t = 14.031558049813768
dt = 0.02662654734788812
Energy error is = 2.3036072157450738e-06 at t = 15.014094578901261
dt = 0.013139824264340233
Energy error is = 4.8480358580405e-06 at t = 16.00527079395158
dt = 0.003242121098723646
Energy error is = 4.9146434806246475e-06 at t = 17.004891415142936
dt = 0.003214639520350663
Energy error is = 2.5505794855329444e-06 at t = 18.01076518740072
dt = 0.013044613802484695
Energy error is = 1.6865574389984817e-06 at t = 19.04237186759994
dt = 0.026861611342587324
Energy error is = 1.5641424602474974e-06 at t = 20.09617343412686
dt = 0.0439893040346404
Energy error is = 2.180797465223261e-06 at t = 21.01473752173859
dt = 0.020675160151769813
Energy error is = 3.469049910179156e-06 at t = 22.00972558345797
dt = 0.008842036831849288
Energy error is = 1.0472118305959732e-05 at t = 23.000024557897277
dt = 0.0004595193006716228
Energy error is = 4.088586187403487e-06 at t = 24.010163222741625
dt = 0.006797349597966504
Energy error is = 2.680777047110903e-06 at t = 25.00236276557927
dt = 0.017640153570364844
Energy error is = 2.0177453242675725e-06 at t = 26.069224282116473
dt = 0.03712788157524145
Energy error is = 2.308495961805823e-06 at t = 27.062866633834965
dt = 0.030038759847067033
Energy error is = 3.1112200927080336e-06 at t = 28.01532612306879
dt = 0.015517937321240514
Energy error is = 5.028027220979614e-06 at t = 29.004111988091758
dt = 0.005017083903993302
Energy error is = 7.414478879030906e-06 at t = 30.000708304268436
dt = 0.0016372110365713427
Energy error is = 3.8975347864123044e-06 at t = 31.002720198451854
dt = 0.01074303532393834
Energy error is = 2.904013339868894e-06 at t = 32.00096198762897
dt = 0.022964555768693034
Energy error is = 2.4684724967000138e-06 at t = 33.020167107725214
dt = 0.07900886084478134
Energy error is = 3.1002978433669615e-06 at t = 34.039563146672066
dt = 0.02327056821267063
Energy error is = 4.1787228725886916e-06 at t = 35.01351842893281
dt = 0.01095968300993155
Energy error is = 7.83491351391552e-06 at t = 36.003132428973856
dt = 0.0017383625615046505
Energy error is = 5.719740678408747e-06 at t = 37.00696514267358
dt = 0.004895918169623749
Energy error is = 3.930017876033198e-06 at t = 38.01075381046989
dt = 0.015286367914312149
Energy error is = 3.1946881935973614e-06 at t = 39.01383897642843
dt = 0.03007457351753507
Energy error is = 3.253359798241484e-06 at t = 40.06547076343983
dt = 0.035497224491678185
Energy error is = 3.958528916714332e-06 at t = 41.015043115345165

dt = 0.01805881378649568
 Energy error is = 5.491132765225726e-06 at t = 42.004390724649326
 dt = 0.006931682962888478
 Energy error is = 1.2467904664026364e-05 at t = 43.00013194443437
 dt = 0.000381254703390189
 Energy error is = 5.274099673630017e-06 at t = 44.01378070103304
 dt = 0.008751742462616716
 Energy error is = 4.0898239242886936e-06 at t = 45.03274488187296
 dt = 0.020558089382172056
 Energy error is = 3.5614859099086793e-06 at t = 46.02866102858705
 dt = 0.04465564725664236
 Energy error is = 4.0158393108252755e-06 at t = 47.040542616951825
 dt = 0.026605844915412773
 Energy error is = 4.956294099162095e-06 at t = 48.022498502296116
 dt = 0.013133474378150647
 Energy error is = 7.465658903721417e-06 at t = 49.00666735260387
 dt = 0.003295591847361852
 Energy error is = 7.638063554804564e-06 at t = 50.000163301430916
 dt = 0.003112843976981032
 dt = 0.003112843976981032

The number of steps = 9360

Q3)

Initial E = -0.6224128509010608
 t = 0.0 dE = 0.0 steps = 0
 semimajor axis = 0.9750175210654083 eccentricity = 0.9036295904145996
 Energy error is = 2.663256567503325e-07 at t = 0.02
 dt = 0.003977648929110488
 Energy error is = 1.928018972807699e-06 at t = 0.5000642694478166
 dt = 8.702223516167413e-05
 Energy error is = 1.1890672296788196e-06 at t = 1.0000235229223124
 dt = 2.255966688423706e-05
 Energy error is = 1.954894372713234e-06 at t = 1.5001779088074028
 dt = 0.0001148934266621503
 Energy error is = 2.684570402755604e-06 at t = 2.0004923703249746
 dt = 0.00036419776750604025
 Energy error is = 3.5826091923096826e-06 at t = 2.5001561803488874
 dt = 9.314270252532509e-05
 Energy error is = 1.6817603620822297e-06 at t = 3.0001399602442804
 dt = 0.00016395109660205515
 Energy error is = 2.44582827257922e-06 at t = 3.5000780562477933
 dt = 5.421263733328397e-05
 Energy error is = 5.179535876309593e-06 at t = 4.00000915098088
 dt = 6.583381444854497e-05
 Energy error is = 1.0195742692009624e-05 at t = 4.500384023117563
 dt = 0.0002378223450576197
 Energy error is = 1.0849776824861657e-05 at t = 5.0000363635526845
 dt = 1.97219162083889e-05
 Energy error is = 6.36546604426691e-06 at t = 5.500025998242737
 dt = 4.090970189255807e-05
 Energy error is = 1.0306075182375807e-05 at t = 6.000137166523423
 dt = 0.00011248304750362759
 Energy error is = 9.260622546802821e-06 at t = 6.5000666232792685
 dt = 0.00018410024744265402

Energy error is = 1.565344073273245e-05 at t = 7.00000066326559
dt = 4.214651192816983e-05
Energy error is = 1.8699669918520456e-05 at t = 7.500032026660609
dt = 4.657611316540754e-05
Energy error is = 2.1635073387482606e-05 at t = 8.000058406118237
dt = 4.2294616528014193e-05
Energy error is = 2.7610302857916658e-05 at t = 8.500030891696612
dt = 4.618989849078718e-05
Energy error is = 2.892474382643062e-05 at t = 9.000008012872334
dt = 3.156525394433451e-05
Energy error is = 2.9335606550162652e-05 at t = 9.500055989379709
dt = 2.6779615665803084e-05
Energy error is = 3.179666825636751e-05 at t = 10.000119583210617
dt = 8.437701208906179e-05
Energy error is = 2.608993738051346e-05 at t = 10.500030640665402
dt = 3.0523268047114993e-05
Energy error is = 2.6216986756311123e-05 at t = 11.000118883634157
dt = 0.0001709741054606185
Energy error is = 3.083969051764779e-05 at t = 11.500039618686893
dt = 3.0730201724411086e-05
Energy error is = 3.839363704394305e-05 at t = 12.000003832759207
dt = 4.320461033994849e-05
Energy error is = 3.7838005157775356e-05 at t = 12.500130463674905
dt = 0.00011368722102330881
Energy error is = 3.951202800323017e-05 at t = 13.000020008501478
dt = 1.5998783389701346e-05
Energy error is = 4.033564724525984e-05 at t = 13.50001897817811
dt = 4.097848054742665e-05
Energy error is = 4.6155305028161564e-05 at t = 14.000054907023314
dt = 2.667482474034737e-05
Energy error is = 4.43677167664136e-05 at t = 14.500053352926981
dt = 2.4911826549259662e-05
Energy error is = 4.662051464709993e-05 at t = 15.000024345022732
dt = 1.608847776253951e-05
Energy error is = 3.863469840748035e-05 at t = 15.500057876802794
dt = 3.654331454933117e-05
Energy error is = 4.165874859352048e-05 at t = 16.000013876666173
dt = 2.235466111365985e-05
Energy error is = 4.890746857844075e-05 at t = 16.500017546741887
dt = 8.839019366064126e-06
Energy error is = 5.133907257037773e-05 at t = 17.000024389645674
dt = 1.7990435078421833e-05
Energy error is = 4.795145592739747e-05 at t = 17.50009492844898
dt = 6.792341922925809e-05
Energy error is = 4.734095931424598e-05 at t = 18.00001491649634
dt = 1.329206107297865e-05
Energy error is = 4.702435457859533e-05 at t = 18.50003288712717
dt = 2.617444109299063e-05
Energy error is = 4.824112962353855e-05 at t = 19.000045808699205
dt = 3.438811800257961e-05
Energy error is = 4.9212242074547774e-05 at t = 19.500034359717475
dt = 4.841286867876508e-05
Energy error is = 5.87462088800228e-05 at t = 20.000060738033042
dt = 4.158148345934587e-05
dt = 4.158148345934587e-05

The number of steps = 309569

