HW4 Phys 305 Christopher Morris

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

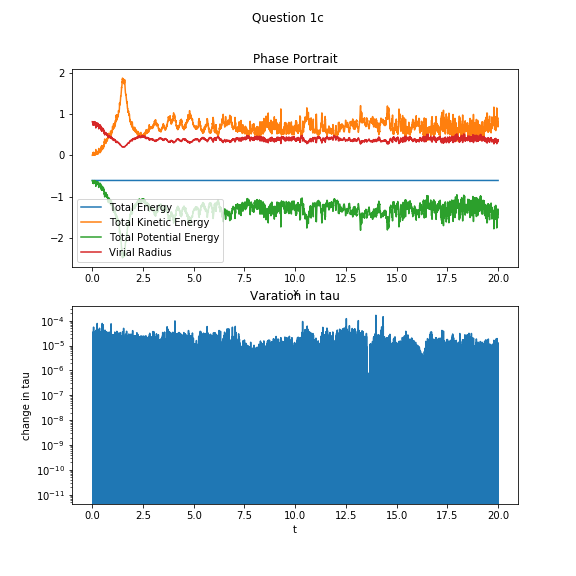
η = .5

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 dEtot = 10e-8

Q3)

The total number of steps is 309569 with a dEtot = 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 Partices = 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 = -0.15601814144919224 and period = 1.4418902860968552

Bound Particles 4 and 19 with orbital energy = -0.010825021836285247 and period = 78.89540221119269

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 Partices = 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 = 1.0000499999998982

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 = 17.000000000002576

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 = 2.6807777047110903e-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 = 0.010743035332393834

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