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Dynamics Hw3 matlab problem 1

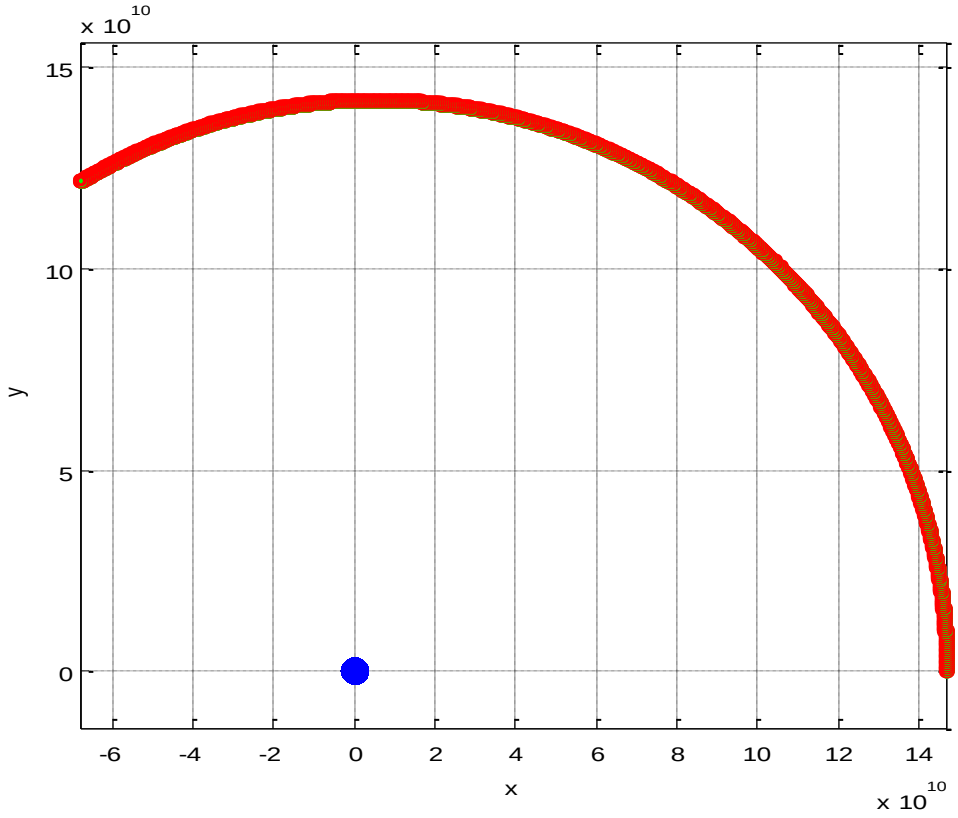
Question A Code

```
clear all;
%clf;
testx1=0;testx2=0;testx3=0;
t0=0; th0 = 0;

%x0 = 5; y0 = 0; z0=0;
%vx0 = 0; vy0 =1.; vz0 = 0.;

x0 =  147e9 ; y0 = 0; z0=0; %Capture
x0_moon = x0+38440000 ; y0_moon = 0; z0_moon=0;

vx0 = 0; vy0 = 2*pi*x0/(365*24*3600); vz0 = 0.;
vx0_moon = 0; vy0_moon = vy0+1030; vz0_moon = 0.;


G=6.67300e-11; %m^3 kg^-1 s^-2

m=5.9742e24;  M=1.98892e30 ; %M is now mass of sun
m_moon = 7.36e22;

xs=x0;ys=y0;zs=z0;
scale1=200; scale2=2000;

%total_time = input('set the total time = ');
total_time = 10e6;
timestep = 43;%unit: s
K = 1000;
%timestep = input('set the timestep = ');
N = floor(total_time/timestep);
fprintf(1,'The number of frames should be less than %d\n',N);
%K = input ('set the number of frames = ');
if K > N
    fprintf(1,'The number of frames must be less than %d\n',N)
    return
end
time_frame=floor(N/K);

time = t0+timestep*[1:N];
r0 = [x0, y0, z0];
v0 = [vx0, vy0, vz0];

r0_moon = [x0_moon, y0_moon, z0_moon];
v0_moon = [vx0_moon, vy0_moon, vz0_moon];

velo = v0; r = r0;
dist_sun2e = sqrt (r * r');
```

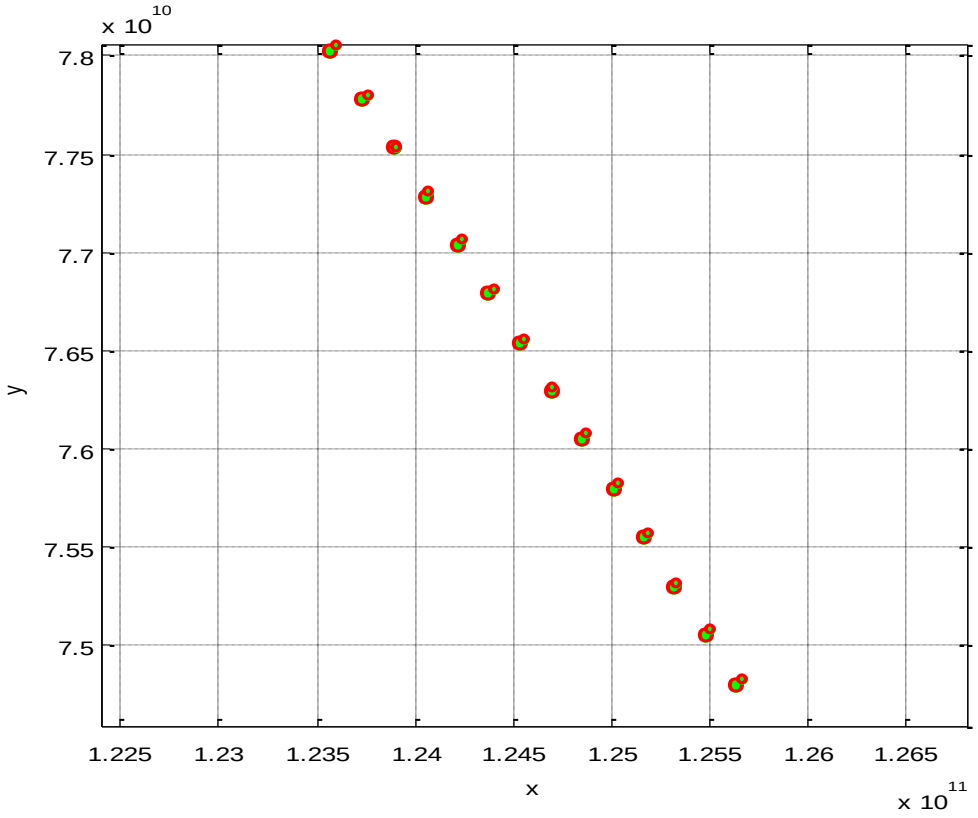
```
force1 = -G*m*M/dist_sun2e^3 * r0;
r_moon2e = r-r0_moon;
dist_moon2e = sqrt(r_moon2e * r_moon2e');
force2 = -G*m*m_moon/dist_moon2e^3 * r_moon2e;
accel = (force1+force2)/m;

velo_moon = v0_moon; r_moon = r0_moon;
dist_moon = sqrt (r_moon * r_moon');
force1 = -G*M*m_moon/dist_moon^3 * r0_moon;
r_e2moon = r0_moon-r;
dist_e2moon = sqrt(r_e2moon * r_e2moon');
force2 = -G*m*m_moon/dist_e2moon^3 * r_e2moon;
accel_moon = (force1+force2)/m_moon;
%plot3 (0, 0, 0); plot3 (10, 10, 10); hold on;
plot (0,0); plot (6,6); hold on;
for i=1:N
    t = i * timestep;
    dt = timestep;
    % Leapfrog algorithm
    velo = velo + 0.5 * dt * accel;
    velo_moon = velo_moon + 0.5 *dt*accel_moon;
    r = r + dt * velo;
    r_moon = r_moon + dt*velo_moon;
    dist_sun2e = sqrt (r * r');
    force1 = - G*M*m/dist_sun2e^3 * r;
    r_moon2e = r-r_moon; dist_moon2e = sqrt(r_moon2e * r_moon2e');
    force2 = -G*m*m_moon/dist_moon2e^3 * r_moon2e;
    accel = (force1+force2)/m;
    velo = velo + 0.5 * dt * accel;
    %%%%%%%%
    dist_moon = sqrt (r_moon * r_moon');
    force1 = -G*M*m_moon/dist_moon^3 * r_moon;
    r_e2moon = r_moon-r; dist_e2moon = sqrt(r_e2moon * r_e2moon');
    force2 = -G*m*m_moon/dist_e2moon^3 * r_e2moon;
    accel_moon = (force1+force2)/m_moon;
    %----------------------------------------
    x=r(1); y=r(2); z=r(3);
    xx=r_moon(1); yy=r_moon(2);
    vx = velo(1); vy = velo(2); vz = velo(3);
    ax = accel(1); ay = accel(2); az = accel(3);
    if mod(i,time_frame)==0
        axis ('equal');
    %plot3(x,y,z,'ro','MarkerEdgeColor','r',...
    %            'MarkerFaceColor','g','LineWidth',2,'MarkerSize',5);

    plot(x,y,'ro','MarkerEdgeColor','r',...
                'MarkerFaceColor','g','LineWidth',2,'MarkerSize',5);
    plot(xx,yy,'ro','MarkerEdgeColor','r',...
                'MarkerFaceColor','g','LineWidth',2,'MarkerSize',2);
    plot(0,0,'bo','MarkerEdgeColor','b',...
                'MarkerFaceColor','b','LineWidth',2,'MarkerSize',10);

    hold on;
    %plot3([0 x],[0, y],[0,z]);
   % if xs~=x0
      % plot3([xs,x],[ys,y],[zs,z],'k')
```

```
    % end;

     vx=scale1*vx; vy=scale1*vy;vz=scale1*vz;
     ax=scale2*ax; ay=scale2*ay;az=scale2*az;
     %plot3([x,x+vx*dt],[y,y+vy*dt],[z,z+vz*dt],'b');
     %plot([x,x+vx*dt],[y,y+vy*dt],'b');
     %plot([xs,x],[ys,y],'k');
    % plot3([x,x+ax*dt],[y,y+ay*dt],[z,z+az*dt],'r');
     %plot([x,x+ax*dt],[y,y+ay*dt],'r');
     %hold on;

    %if (testx1~=1 & testx2~=1 & testx3~=1)
     %   axis([min_x1 max_x1 min_x2 max_x2 min_x3 max_x3]);
     %end

     grid on;
     xlabel('x');ylabel('y');
     zlabel('z');
     drawnow
     %pause(0.2)
     xs=x;ys=y;zs=z;
     end
end
```

Question A Plot



Zoomed in:



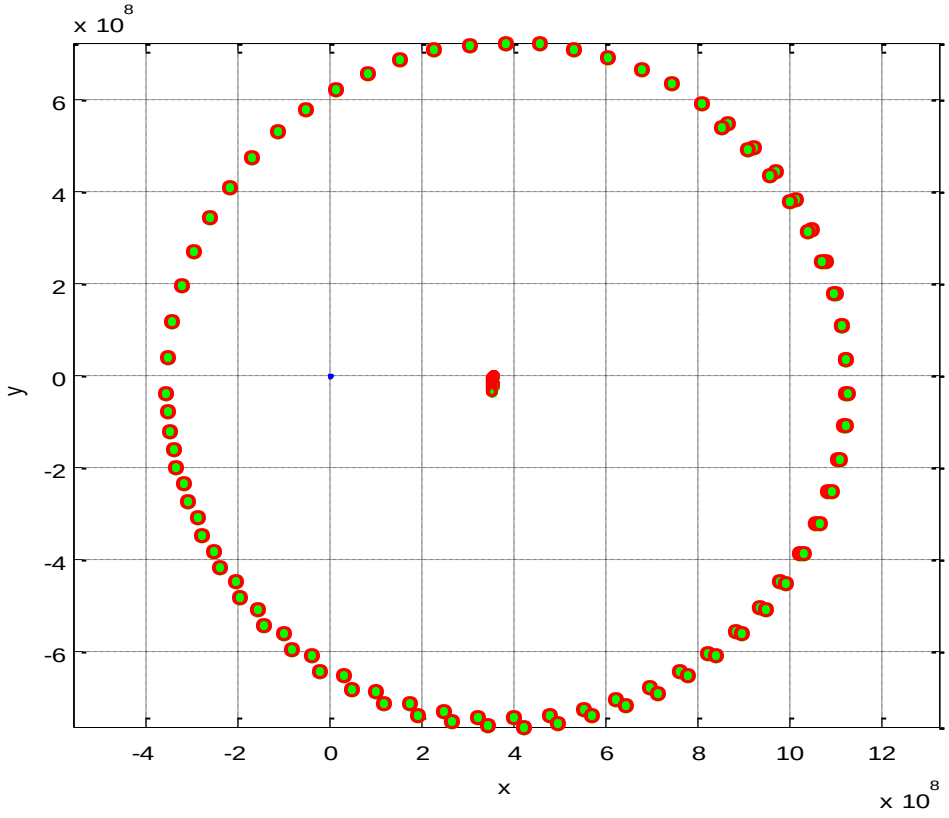
Question B Code

```
clear all;
%clf;
testx1=0;testx2=0;testx3=0;
t0=0; th0 = 0;

%x0 = 5; y0 = 0; z0=0;
%vx0 = 0; vy0 =1.; vz0 = 0.;

x0 =  -356400e3 ; y0 = 0; z0=0;  %x0 is star 1
x0_moon = 356400e3 ; y0_moon = 0; z0_moon=0;  %moon is now star 2!!!!!!!!!!!!

vx0 = 0; vy0 = -80; vz0 = 0.;
vx0_moon = 0; vy0_moon = 0;%-.02*vy0;
vz0_moon = 0.;


G=6.67300e-11; %m^3 kg^-1 s^-2

roe = 1e3;% kg/m^3
R = 5e5;

m=roe*(4/3)*pi*R^3;
```

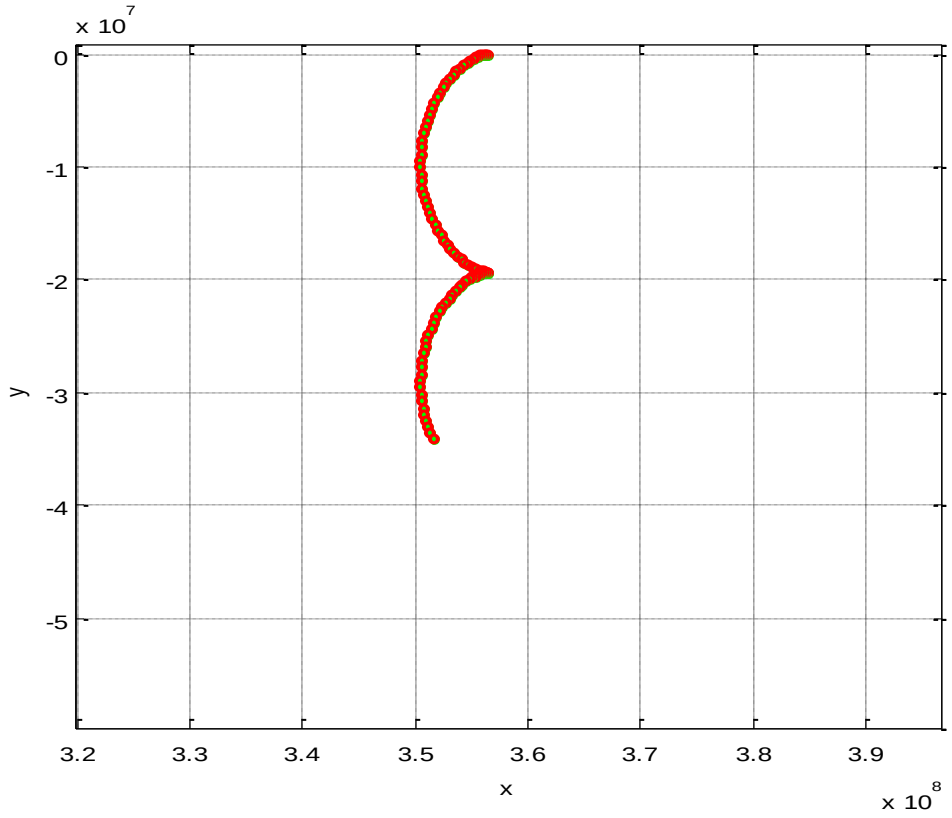
```
m_moon = roe*(4/3)*pi*(5*R)^3;

xs=x0;ys=y0;zs=z0;
scale1=200; scale2=2000;

%total_time = input('set the total time = ');
total_time = 10e7;
timestep = 1000;%unit: s
K = 100;
%timestep = input('set the timestep = ');
N = floor(total_time/timestep);
fprintf(1,'The number of frames should be less than %d\n',N);
%K = input ('set the number of frames = ');
if K > N
    fprintf(1,'The number of frames must be less than %d\n',N)
    return
end
time_frame=floor(N/K);

time = t0+timestep*[1:N];
r0 = [x0, y0, z0];
v0 = [vx0, vy0, vz0];

r0_moon = [x0_moon, y0_moon, z0_moon];
v0_moon = [vx0_moon, vy0_moon, vz0_moon];

velo = v0; r = r0;
dist_sun2e = sqrt (r * r');
force1 = [0 0 0];%-G*m*M/dist_sun2e^3 * r0;
r_moon2e = r-r0_moon;
dist_moon2e = sqrt(r_moon2e * r_moon2e');
force2 = -G*m*m_moon/dist_moon2e^3 * r_moon2e;
accel = (force1+force2)/m;

velo_moon = v0_moon; r_moon = r0_moon;
dist_moon = sqrt (r_moon * r_moon');
force1 = [0 0 0];%-G*M*m_moon/dist_moon^3 * r0_moon;
r_e2moon = r0_moon-r;
dist_e2moon = sqrt(r_e2moon * r_e2moon');
force2 = -G*m*m_moon/dist_e2moon^3 * r_e2moon;
accel_moon = (force1+force2)/m_moon;
%plot3 (0, 0, 0); plot3 (10, 10, 10); hold on;
plot (0,0); plot (6,6); hold on;
for i=1:N
    t = i * timestep;
    dt = timestep;
    % Leapfrog algorithm
    velo = velo + 0.5 * dt * accel;
    velo_moon = velo_moon + 0.5 *dt*accel_moon;
    r = r + dt * velo;
    r_moon = r_moon + dt*velo_moon;
    dist_sun2e = sqrt (r * r');
    force1 = [0 0 0];%- G*M*m/dist_sun2e^3 * r;
    r_moon2e = r-r_moon; dist_moon2e = sqrt(r_moon2e * r_moon2e');
    force2 = -G*m*m_moon/dist_moon2e^3 * r_moon2e;
    accel = (force1+force2)/m;
```

```
    velo = velo + 0.5 * dt * accel;
    %%%%%%%%
    dist_moon = sqrt (r_moon * r_moon');
    force1 = [0 0 0];%-G*M*m_moon/dist_moon^3 * r_moon;
    r_e2moon = r_moon-r; dist_e2moon = sqrt(r_e2moon * r_e2moon');
    force2 = -G*m*m_moon/dist_e2moon^3 * r_e2moon;
    accel_moon = (force1+force2)/m_moon;
    %----------------------------------------
    x=r(1); y=r(2); z=r(3);
    xx=r_moon(1); yy=r_moon(2);
    vx = velo(1); vy = velo(2); vz = velo(3);
    ax = accel(1); ay = accel(2); az = accel(3);
    if mod(i,time_frame)==0
        axis ('equal');
    %plot3(x,y,z,'ro','MarkerEdgeColor','r',...
    %            'MarkerFaceColor','g','LineWidth',2,'MarkerSize',5);

    plot(x,y,'ro','MarkerEdgeColor','r',...
                'MarkerFaceColor','g','LineWidth',2,'MarkerSize',5);
    plot(xx,yy,'ro','MarkerEdgeColor','r',...
                'MarkerFaceColor','g','LineWidth',2,'MarkerSize',2);



    hold on;
    %plot3([0 x],[0, y],[0,z]);
   % if xs~=x0
      % plot3([xs,x],[ys,y],[zs,z],'k')
   % end;

    vx=scale1*vx; vy=scale1*vy;vz=scale1*vz;
    ax=scale2*ax; ay=scale2*ay;az=scale2*az;
    %plot3([x,x+vx*dt],[y,y+vy*dt],[z,z+vz*dt],'b');
    %plot([x,x+vx*dt],[y,y+vy*dt],'b');
    %plot([xs,x],[ys,y],'k');
   % plot3([x,x+ax*dt],[y,y+ay*dt],[z,z+az*dt],'r');
    %plot([x,x+ax*dt],[y,y+ay*dt],'r');
    %hold on;

   %if (testx1~=1 & testx2~=1 & testx3~=1)
    %   axis([min_x1 max_x1 min_x2 max_x2 min_x3 max_x3]);
    %end

    grid on;
    xlabel('x');ylabel('y');
    zlabel('z');
    drawnow
    %pause(0.2)
    xs=x;ys=y;zs=z;
    end
end
```

Question B Plot



Zoomed in on middle:



Question C Code

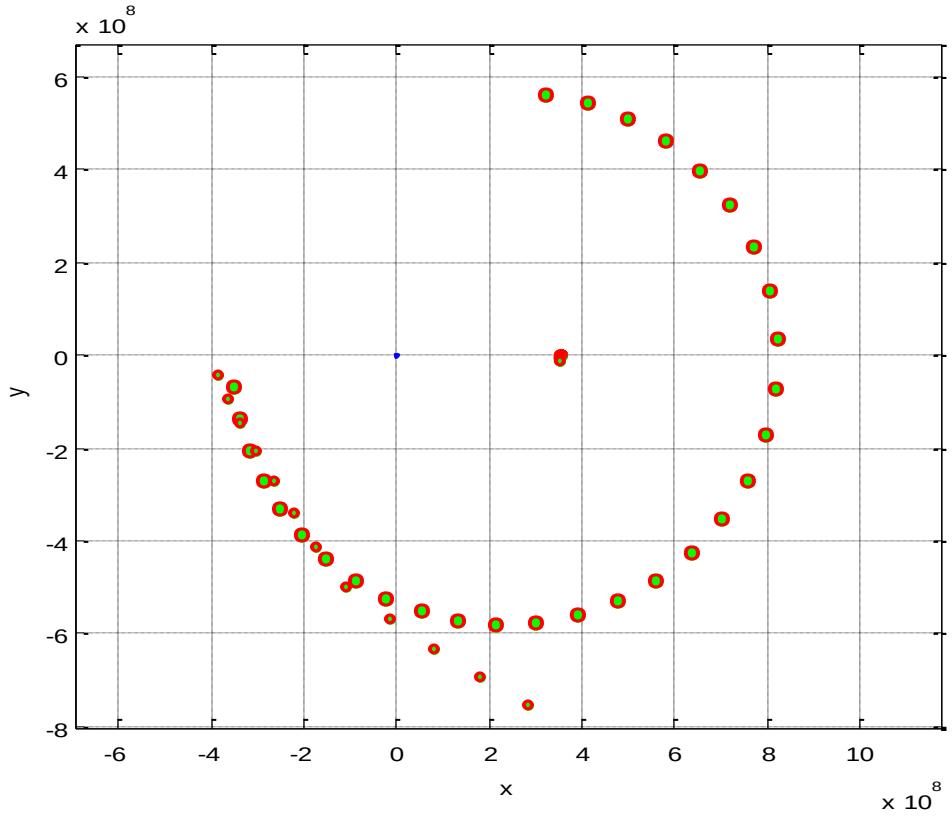
```
clear all;
%clf;
testx1=0;testx2=0;testx3=0;
t0=0; th0 = 0;

%x0 = 5; y0 = 0; z0=0;
%vx0 = 0; vy0 =1.; vz0 = 0.;

x0 =  -356400e3 ; y0 = 0; z0=0;  %x0 is star 1
x0_moon = 356400e3 ; y0_moon = 0; z0_moon=0;  %moon is now star 2!!!!!!!!!!!!
x0_star3 = x0*1.1; y0_star3 = 0; z0_star3=0;

vx0 = 0; vy0 = -70; vz0 = 0.;
vx0_moon = 0; vy0_moon = 0;vz0_moon = 0.;
vx0_star3 = 0; vy0_star3 = 0.6*vy0;vz0_star3 = 0.;

G=6.67300e-11; %m^3 kg^-1 s^-2

roe = 1e3;% kg/m^3
R = 5e5;

m=roe*(4/3)*pi*R^3;
```

```
m_moon = roe*(4/3)*pi*(5*R)^3;
m_star3 = roe*(4/3)*pi*(R/4)^3;
xs=x0;ys=y0;zs=z0;
scale1=200; scale2=2000;

%total_time = input('set the total time = ');
total_time = 10e7;
timestep = 100;%unit: s
K = 100;
%timestep = input('set the timestep = ');
N = floor(total_time/timestep);
fprintf(1,'The number of frames should be less than %d\n',N);
%K = input ('set the number of frames = ');
if K > N
    fprintf(1,'The number of frames must be less than %d\n',N)
    return
end
time_frame=floor(N/K);

time = t0+timestep*[1:N];
r0 = [x0, y0, z0];
v0 = [vx0, vy0, vz0];

r0_moon = [x0_moon, y0_moon, z0_moon];
v0_moon = [vx0_moon, vy0_moon, vz0_moon];

r0_star3 = [x0_star3, y0_star3, z0_star3];
v0_star3 = [vx0_star3, vy0_star3, vz0_star3];

velo = v0; r = r0; %this is earth in notation but is middle heaviest star in
this simulation
dist_sun2e = sqrt (r * r');
force1 = [0 0 0];%-G*m*M/dist_sun2e^3 * r0;
r_moon2e = r-r0_moon;
dist_moon2e = sqrt(r_moon2e * r_moon2e');
force2 = -G*m*m_moon/dist_moon2e^3 * r_moon2e;
accel = (force1+force2)/m;

velo_moon = v0_moon; r_moon = r0_moon; %moon is the heaviest star in this
simulation
dist_moon = sqrt (r_moon * r_moon');
force1 = [0 0 0];%-G*M*m_moon/dist_moon^3 * r0_moon;
r_e2moon = r0_moon-r;
dist_e2moon = sqrt(r_e2moon * r_e2moon');
force2 = -G*m*m_moon/dist_e2moon^3 * r_e2moon;
accel_moon = (force1+force2)/m_moon;

velo_star3 = v0_star3; r_star3 = r0_star3;
r_moon2star3 = r_star3 - r_moon;
dist_moon2star3 = sqrt(r_moon2star3 * r_moon2star3');
force1 = -G*m_star3*m_moon/dist_moon2star3^3 * r_moon2star3;
r_e2star3 = r_star3 - r;
dist_e2star3 = sqrt(r_e2star3 * r_e2star3');
force2 = -G*m_star3*m/dist_e2star3^3 * r_e2star3;
accel_star3 = (force1+force2)/m_star3;
```

```
%plot3 (0, 0, 0); plot3 (10, 10, 10); hold on;
plot (0,0); plot (6,6); hold on;
for i=1:N
    t = i * timestep;
    dt = timestep;
    % Leapfrog algorithm
    velo = velo + 0.5 * dt * accel;
    velo_moon = velo_moon + 0.5 *dt*accel_moon;
    velo_star3 = velo_star3 + 0.5*dt*accel_star3;
    r = r + dt * velo;
    r_moon = r_moon + dt*velo_moon;
    r_star3 = r_star3+ dt*velo_star3;

    dist_sun2e = sqrt (r * r');
    force1 = [0 0 0];%- G*M*m/dist_sun2e^3 * r;
    r_moon2e = r-r_moon; dist_moon2e = sqrt(r_moon2e * r_moon2e');
    force2 = -G*m*m_moon/dist_moon2e^3 * r_moon2e;
    accel = (force1+force2)/m;
    velo = velo + 0.5 * dt * accel;
    %%%%%%%%
    dist_moon = sqrt (r_moon * r_moon');
    force1 = [0 0 0];%-G*M*m_moon/dist_moon^3 * r_moon;
    r_e2moon = r_moon-r; dist_e2moon = sqrt(r_e2moon * r_e2moon');
    force2 = -G*m*m_moon/dist_e2moon^3 * r_e2moon;
    accel_moon = (force1+force2)/m_moon;
    %%%%%%%%%%
    dist_moon2star3 = sqrt(r_moon2star3 * r_moon2star3');
    force1 = -G*m_star3*m_moon/dist_moon2star3^3 * r_moon2star3;
    r_e2star3 = r_star3 - r;
    dist_e2star3 = sqrt(r_e2star3 * r_e2star3');
    force2 = -G*m_star3*m/dist_e2star3^3 * r_e2star3;
    accel_star3 = (force1+force2)/m_star3;


    %----------------------------------------
    x=r(1); y=r(2); z=r(3);
    xx=r_moon(1); yy=r_moon(2);
    xxx=r_star3(1); yyy=r_star3(2);
    vx = velo(1); vy = velo(2); vz = velo(3);
    ax = accel(1); ay = accel(2); az = accel(3);
    if mod(i,time_frame)==0
        axis ('equal');
    %plot3(x,y,z,'ro','MarkerEdgeColor','r',...
    %            'MarkerFaceColor','g','LineWidth',2,'MarkerSize',5);

    plot(x,y,'ro','MarkerEdgeColor','r',...
                'MarkerFaceColor','g','LineWidth',2,'MarkerSize',5);
    plot(xx,yy,'ro','MarkerEdgeColor','r',...
                'MarkerFaceColor','g','LineWidth',2,'MarkerSize',2);
    plot(xxx,yyy,'ro','MarkerEdgeColor','r',...
                'MarkerFaceColor','g','LineWidth',2,'MarkerSize',2);

    hold on;
    %plot3([0 x],[0, y],[0,z]);
   % if xs~=x0
      % plot3([xs,x],[ys,y],[zs,z],'k')
```

```
    % end;

     vx=scale1*vx; vy=scale1*vy;vz=scale1*vz;
     ax=scale2*ax; ay=scale2*ay;az=scale2*az;
     %plot3([x,x+vx*dt],[y,y+vy*dt],[z,z+vz*dt],'b');
     %plot([x,x+vx*dt],[y,y+vy*dt],'b');
     %plot([xs,x],[ys,y],'k');
    % plot3([x,x+ax*dt],[y,y+ay*dt],[z,z+az*dt],'r');
     %plot([x,x+ax*dt],[y,y+ay*dt],'r');
     %hold on;

    %if (testx1~=1 & testx2~=1 & testx3~=1)
     %   axis([min_x1 max_x1 min_x2 max_x2 min_x3 max_x3]);
     %end

     grid on;
     xlabel('x');ylabel('y');
     zlabel('z');
     drawnow
     %pause(0.2)
     xs=x;ys=y;zs=z;
     end
end
```

Question C Plot


x 10^8
6
4
2
0
-2
-4
-6
-8
y
-6
-4
-2
0
2
4
6
8
10
x
x 10^8