```
eulertimer(1000)
Max error over time steps: 0.8661

ans =

     1.999999999998181e-02

eulertimer(2000)
Max error over time steps: 0.47599

ans =

     2.000000000003865e-02

eulertimer(3000)
Max error over time steps: 0.32375

ans =

     2.000000000003865e-02

eulertimer(4000)
Max error over time steps: 0.24463

ans =

     3.999999999996362e-02

eulertimer(5000)
Max error over time steps: 0.19641

ans =

     3.999999999996362e-02

eulertimer(6000)
Max error over time steps: 0.164

ans =

     6.000000000000227e-02

eulertimer(7000)
Max error over time steps: 0.14074

ans =

     5.000000000001137e-02

eulertimer(8000)
Max error over time steps: 0.12325

ans =
```

```
      5.000000000001137e-02

eulertimer(9000)
Max error over time steps: 0.10962

ans =

      5.000000000001137e-02

eulertimer(10000)
Max error over time steps: 0.098698

ans =

      6.999999999999318e-02

eulertimer(11000)
Max error over time steps: 0.089753

ans =

      5.000000000001137e-02

eulertimer(12000)
Max error over time steps: 0.082293

ans =

      5.000000000001137e-02

eulertimer(13000)
Max error over time steps: 0.075977

ans =

      5.000000000001137e-02

eulertimer(14000)
Max error over time steps: 0.07056

ans =

      5.000000000001137e-02

eulertimer(15000)
Max error over time steps: 0.065864

ans =

      3.999999999996362e-02

eulertimer(16000)
Max error over time steps: 0.061754
```

```
ans =

     4.999999999995453e-02
euler(0,4 * pi,[512 64 8 1],@(t,w,r) [w(3), w(4), -1*w(1)/((w(1)^2) +
(w(2)^2)), -1*w(2)/((w(1)^2) + (w(2)^2))], 0,1000)
Max error over time steps: 611.3883

ans =

  Columns 1 through 2

     6.123883085089058e+02     7.654853856361322e+01

  Columns 3 through 4

     7.977931682142508e+00     9.972414602678135e-01

euler(0,4 * pi,[512 64 8 1],@(t,w,r) [w(3), w(4), -1*w(1)/((w(1)^2) +
(w(2)^2)), -1*w(2)/((w(1)^2) + (w(2)^2))], 0,10000)
Max error over time steps: 611.3882

ans =

  Columns 1 through 2

     6.123881955746932e+02     7.654852444683665e+01

  Columns 3 through 4

     7.977933462707102e+00     9.972416828383878e-01

euler(0,4 * pi,[512 64 8 1],@(t,w,r) [w(3), w(4), -1*w(1)/((w(1)^2) +
(w(2)^2)), -1*w(2)/((w(1)^2) + (w(2)^2))], 0,100000)
Max error over time steps: 611.3882

ans =

  Columns 1 through 2

     6.123881842826789e+02     7.654852303533487e+01

  Columns 3 through 4

     7.977933640752759e+00     9.972417050940949e-01

euler(0,4 * pi,[512 64 8 1],@(t,w,r) [w(3), w(4), -1*w(1)/((w(1)^2) +
(w(2)^2)), -1*w(2)/((w(1)^2) + (w(2)^2))], 0,1000000)
Max error over time steps: 611.3882

ans =

  Columns 1 through 2

     6.123881831535132e+02     7.654852289418915e+01
```

```
   Columns 3 through 4

      7.977933658557729e+00      9.972417073197161e-01

diary off
euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,1000)
Max error over time steps: 106.7026

ans =

   Columns 1 through 2

      1.052189255262397e+01     -1.052265966543978e+02

   Columns 3 through 4

     -1.057253240214396e+02     -1.679080482333963e+01

euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,2000)
Max error over time steps: 49.587

ans =

   Columns 1 through 2

     -2.341938007407561e+01     -4.584824261309700e+01

   Columns 3 through 4

     -4.442183078668573e+01      2.081102544452048e+01

euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,3000)
Max error over time steps: 42.8159

ans =

   Columns 1 through 2

     -4.137975249478973e+01     -2.172557583013495e+01

   Columns 3 through 4

     -1.925544016200353e+01      4.026436731861682e+01

euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,4000)
Max error over time steps: 82.2343

ans =
```

```
   Columns 1 through 2

    -8.244625714158386e+01    -3.258893360023003e+01

   Columns 3 through 4

    -2.761938722490694e+01     8.081238656240852e+01

euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,5000)
Max error over time steps: 271.4475

ans =

   Columns 1 through 2

    -2.424578006196213e+02    -1.691295024673601e+02

   Columns 3 through 4

    -1.544476058727464e+02     2.331798407534149e+02

euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,20000)
Max error over time steps: 4.0257

ans =

   Columns 1 through 2

     3.997186045197733e-01     2.522998493506851e+00

   Columns 3 through 4

     2.761049380380465e+00    -6.019765375596542e-01

euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,50000)
Max error over time steps: 3.0016

ans =

   Columns 1 through 2

     8.997139700641387e-01     6.711548709570363e-01

   Columns 3 through 4

     6.001031079454997e-01    -1.122537987314529e-01

euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,75000)
Max error over time steps: 3.0016
```

```
ans =

  Columns 1 through 2

     9.143661629378346e-01     5.777724330878958e-01

  Columns 3 through 4

     7.145361661924510e-01     -2.537816471537478e-01

euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,100000)
Max error over time steps: 3.0016

ans =

  Columns 1 through 2

     9.260572178589652e-01     5.110934604237509e-01

  Columns 3 through 4

     6.677770532131945e-01     -2.707218207111333e-01

euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,1024000)
Max error over time steps: 3.0016

ans =

  Columns 1 through 2

     9.912419954134595e-01     4.884884812990736e-01

  Columns 3 through 4

     9.241424758454164e-02     -3.666375577836178e-01

eulertimer(1000)
Max error over time steps: 106.7026

ans =

  Columns 1 through 2

     1.052189255262397e+01     -1.052265966543978e+02

  Columns 3 through 4

    -1.057253240214396e+02     -1.679080482333963e+01


ans =
```

```
        5.000000000001137e-02

eulertimer(10000)
Max error over time steps: 49.545

ans =

  Columns 1 through 2

     4.279798489098799e+01     3.163480974100889e+01

  Columns 3 through 4

     2.905762290238256e+01    -4.104483632710801e+01


ans =

     8.000000000001251e-02

eulertimer(100000)
Max error over time steps: 3.0016

ans =

  Columns 1 through 2

     9.260572178589652e-01     5.110934604237509e-01

  Columns 3 through 4

     6.677770532131945e-01    -2.707218207111333e-01


ans =

     9.999999999999432e-02

eulertimer(1024000)
Max error over time steps: 3.0016

ans =

  Columns 1 through 2

     9.912419954134595e-01     4.884884812990736e-01

  Columns 3 through 4

     9.241424758454164e-02    -3.666375577836178e-01
```

```
ans =

     8.499999999999943e-01

diary off
```

FUNCTIONS

```
function u = euler(a,b,ya,f,r,n)

h = (b-a)/n;
t = a;
w = ya;
error = 0;
x = zeros(1,n);
y = zeros(1,n);

for i = 1:n
    w = w + h*f(t,w,r);
    t = a + i*h;
    x(i) = w(1);
    y(i) = w(2);
    error = max( [error, abs(w(1) - cos(t)), abs(w(2) - sin(t)), abs(w(3) +
sin(t)), abs(w(4) - cos(t))] );
end

plot(x,y)

X = ['Max error over time steps: ', num2str(error)];
disp(X)

u = w;

end


function time = eulertimer(n)
t = cputime;
euler(0,17.06521656015796,[0.994 0 0 -2.00158510637908],@(t,u,r)
satellite(t,u,r), 0,n)
time = cputime-t;
end

function uprime = satellite(t, u, r)

a = 0.012277471;
b = 1-a;

x2p = u(1) + 2*u(4) - (b * ( (u(1) + a) / ( (u(1) + a)^2 + u(3)^2 )^(3/2) )
)...
    - (a * ( (u(1) - b) / ( (u(1) - b)^2 + u(3)^2 )^(3/2) ) );

y2p = u(3) - 2*u(2) - (b * ( u(3) / ( (u(1) + a)^2 + u(3)^2 )^(3/2) ) )...
    - (a * ( u(3) / ( (u(1) - b)^2 + u(3)^2 )^(3/2) ) );
```

```
uprime = [u(2), x2p, u(4), y2p];
```
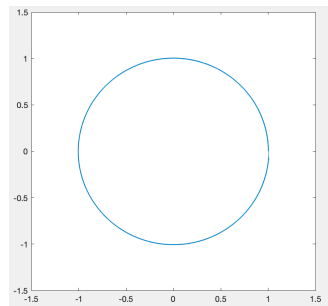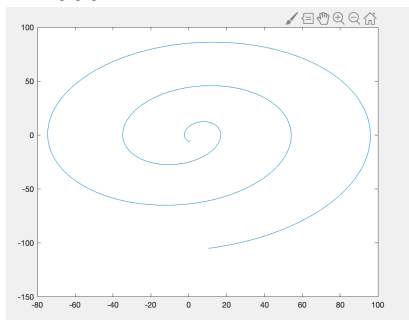
```
end
```

GRAPHS

3b1000
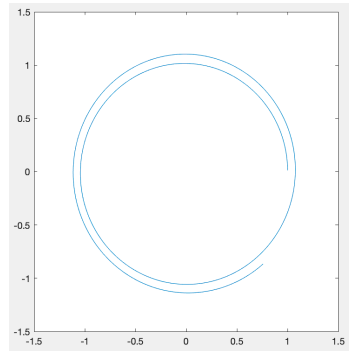
3b5000
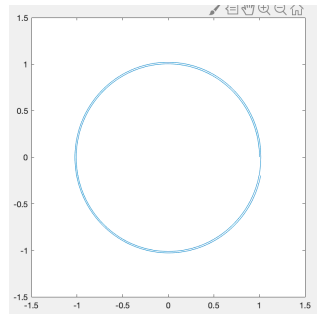
3b10000

3b16000
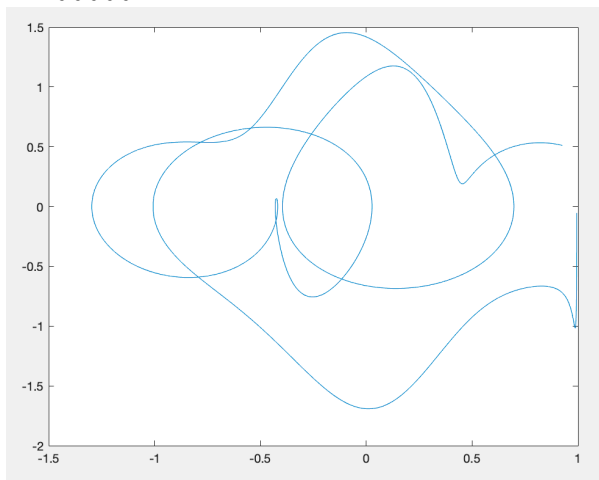
4b1000

4b5000

X 0.535
Y 6.84

4b20000

4b50000

X -0.3022
Y -0.5077
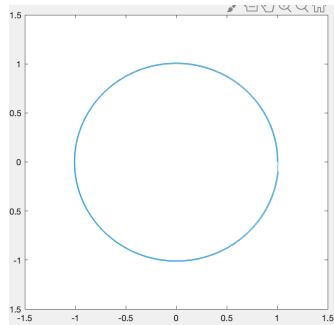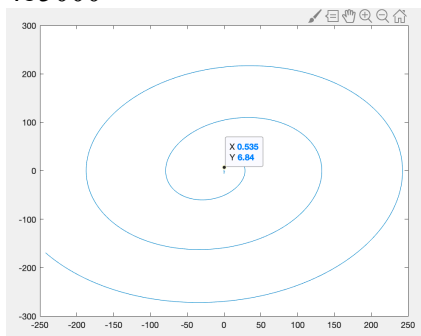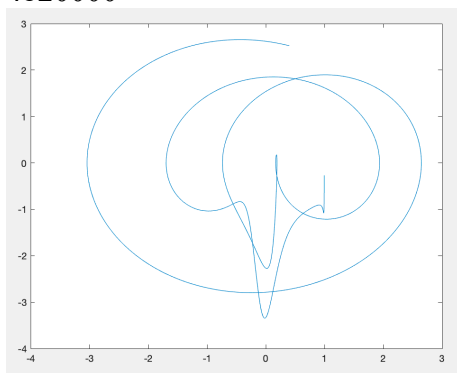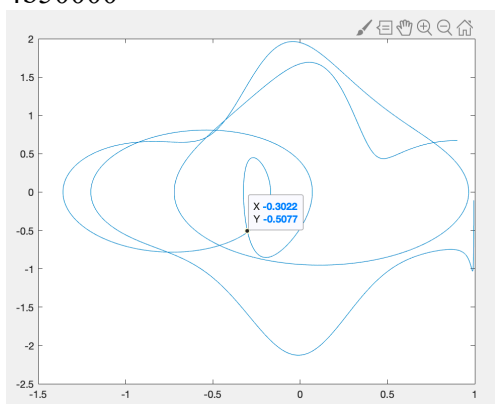
4b75000

4b100000

4b1024000