# Assignment 3

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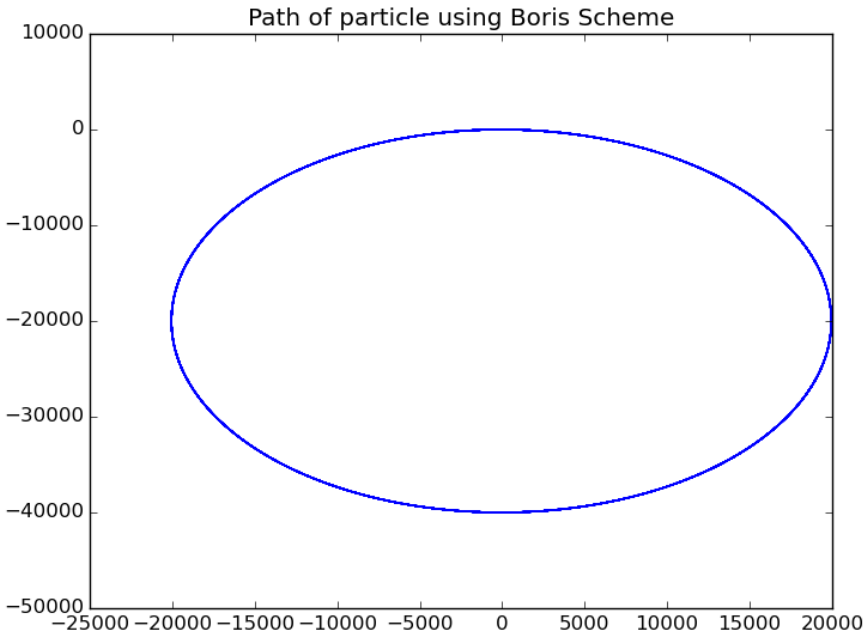
November 15, 2016

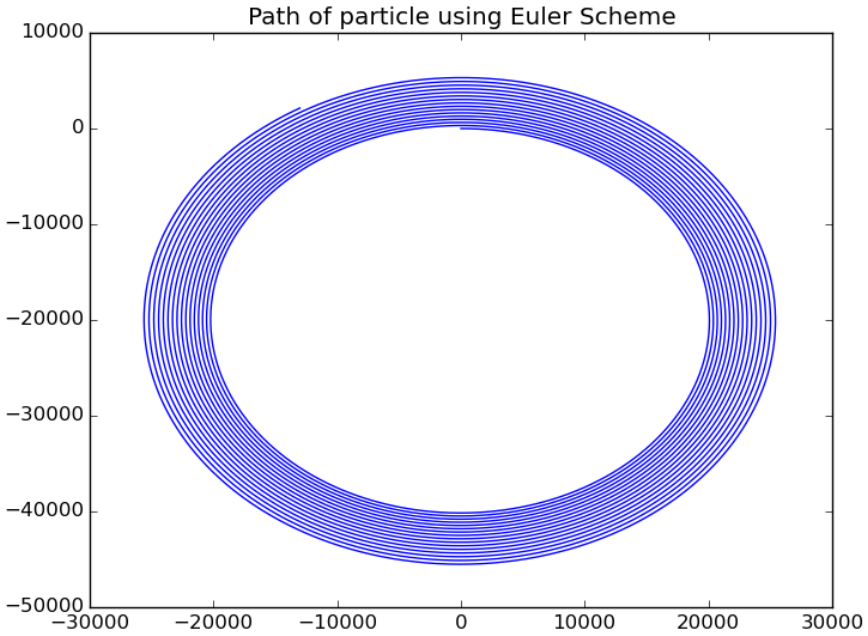
# 1 Question1:

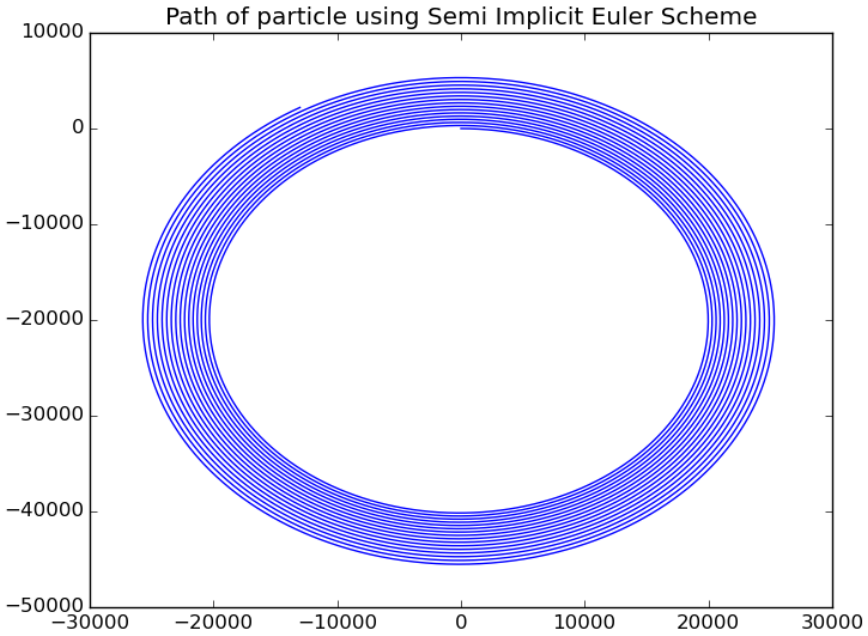
The following plots show the results of the simulation of a charged particle motion under the influence of a constant magnetic field and no electric field.

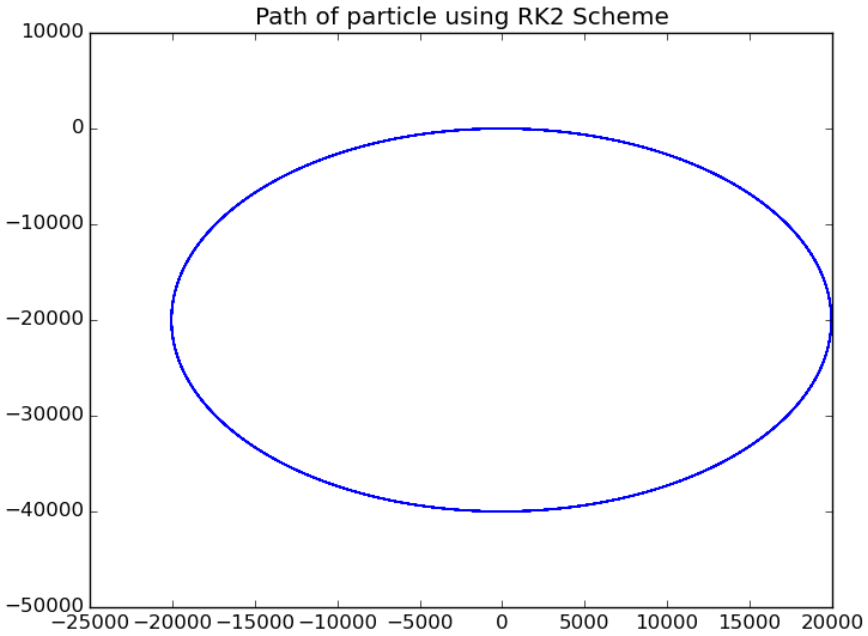
## 1.1 Paths using Different Schemes

Refer code for the values used for the simulation.

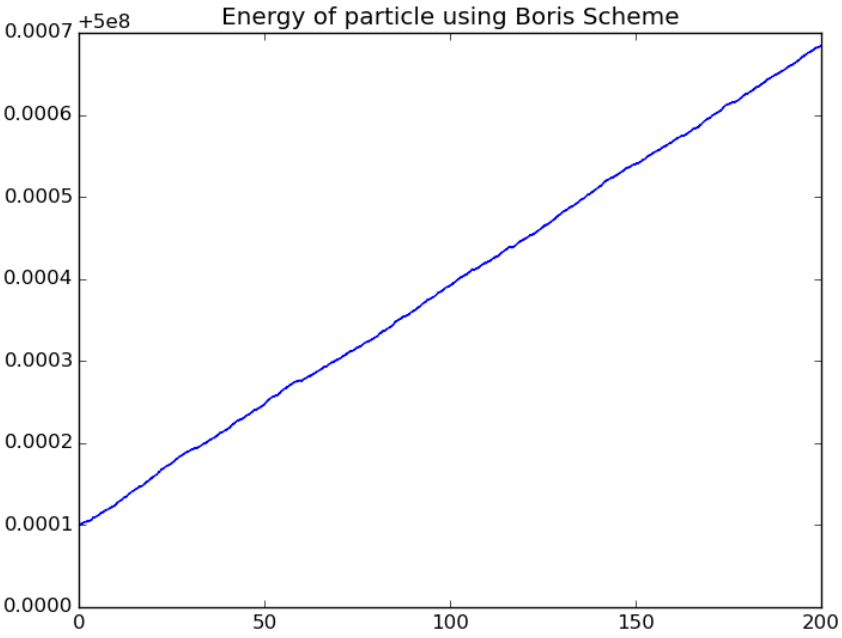


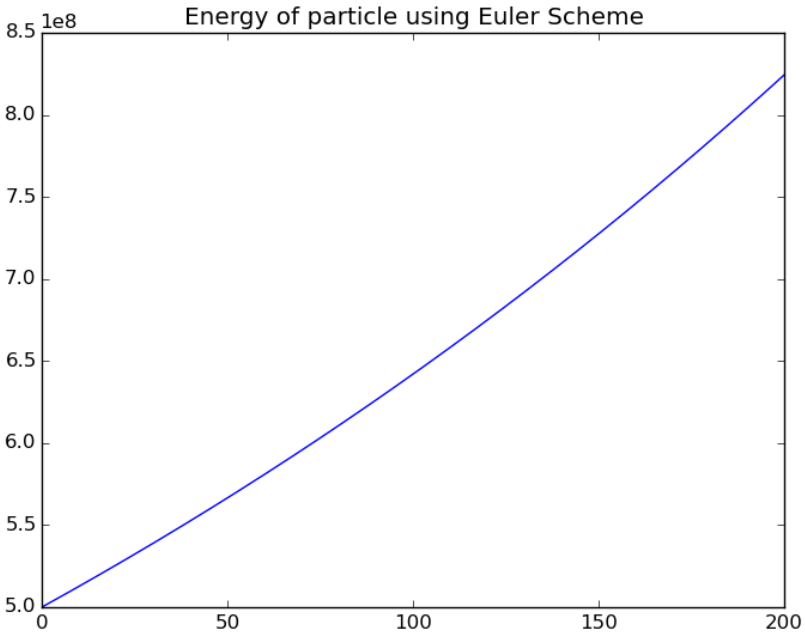

Path of particle using Euler Scheme
10000
0
−10000
−20000
−30000
−40000
−50000
−30000
−20000
−10000
0
10000
20000
30000

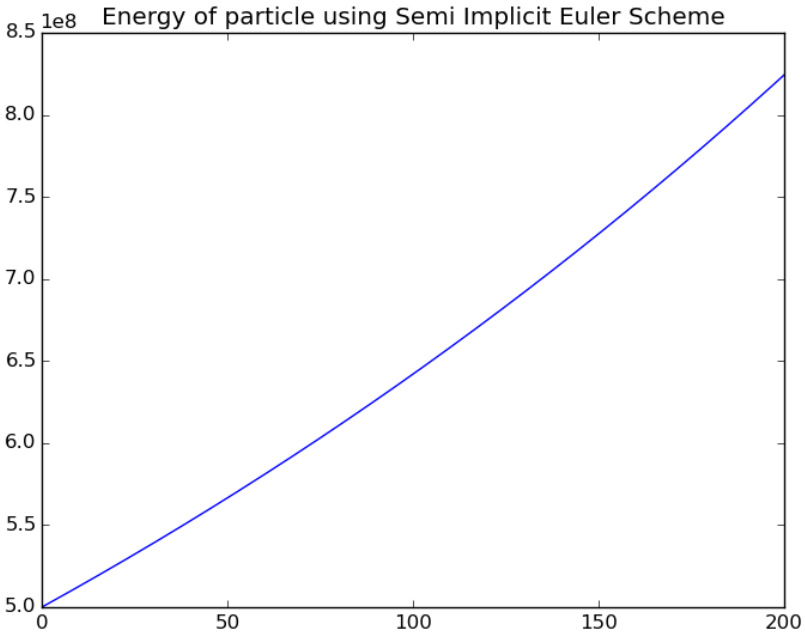

Path of particle using Semi Implicit Euler Scheme
10000
0
−10000
−20000
−30000
−40000
−50000
−30000
−20000
−10000
0
10000
20000
30000

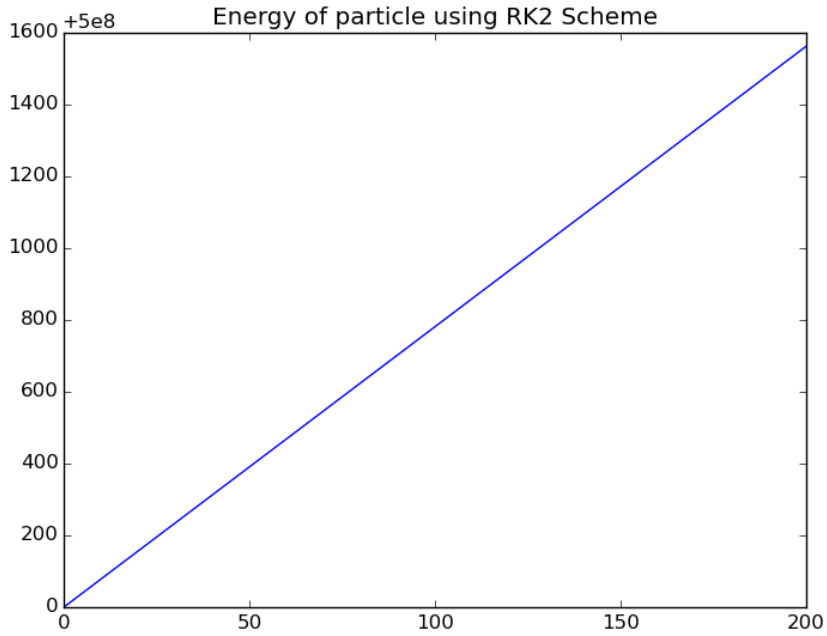



## 1.2 Energy Development with time using Different Schemes

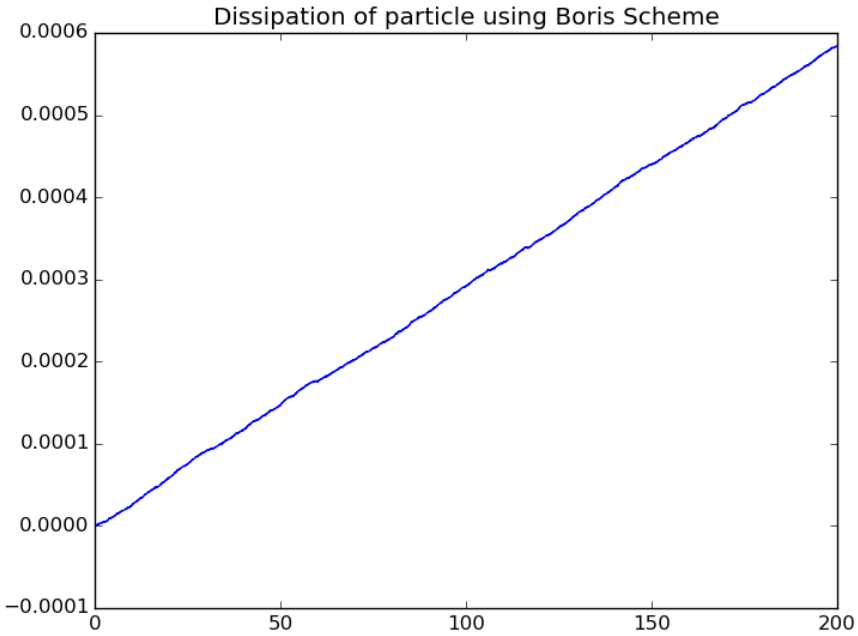


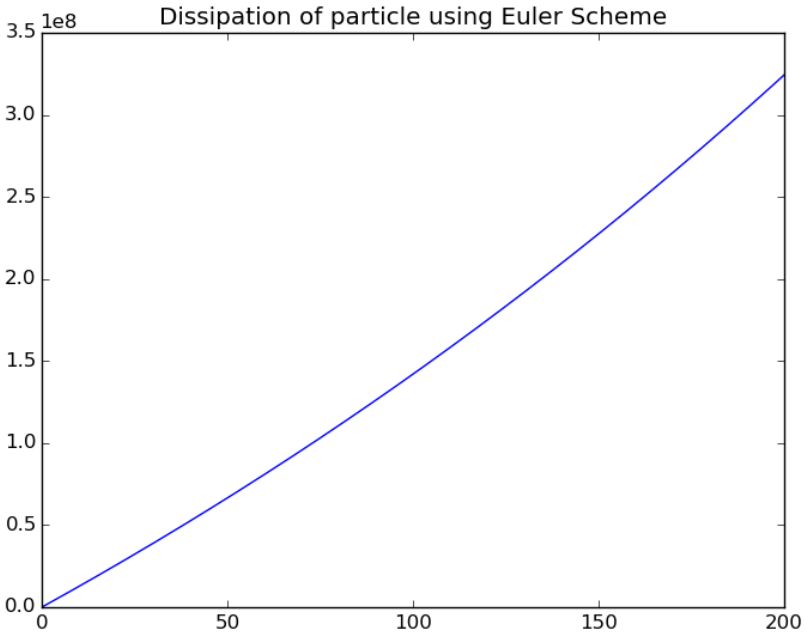

Energy of particle using Euler Scheme
1e8
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
0
50
100
150
200

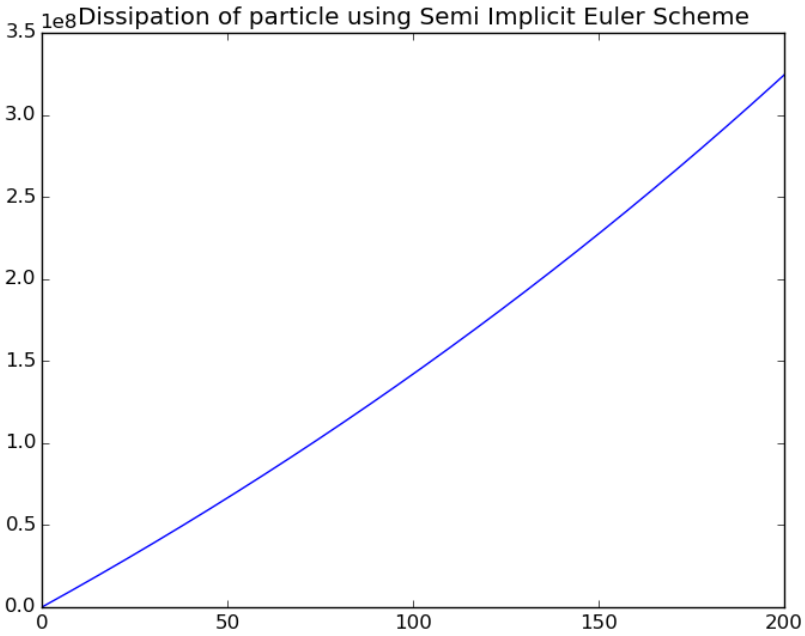

Energy of particle using Semi Implicit Euler Scheme
1e8
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
0
50
100
150
200

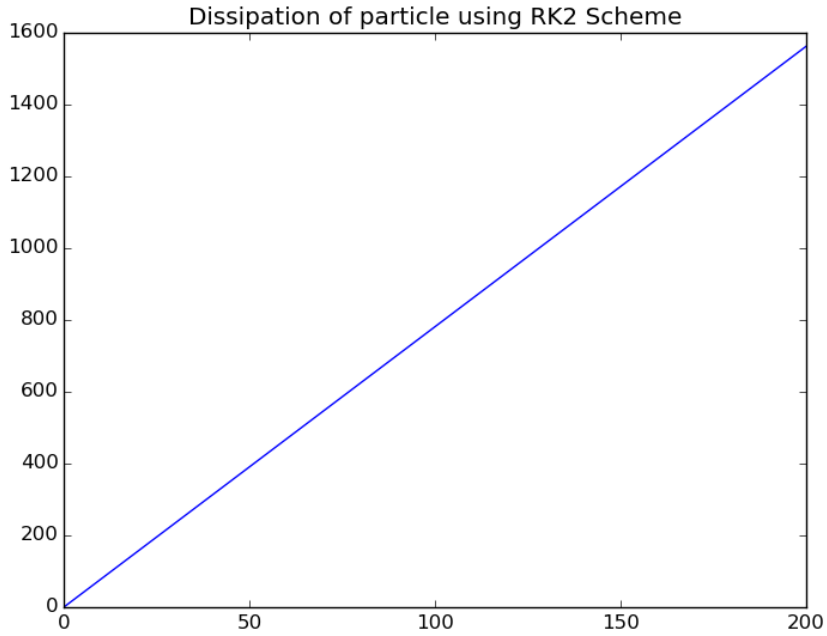



### 1.3 Dissipation of energy with time using Different Schemes

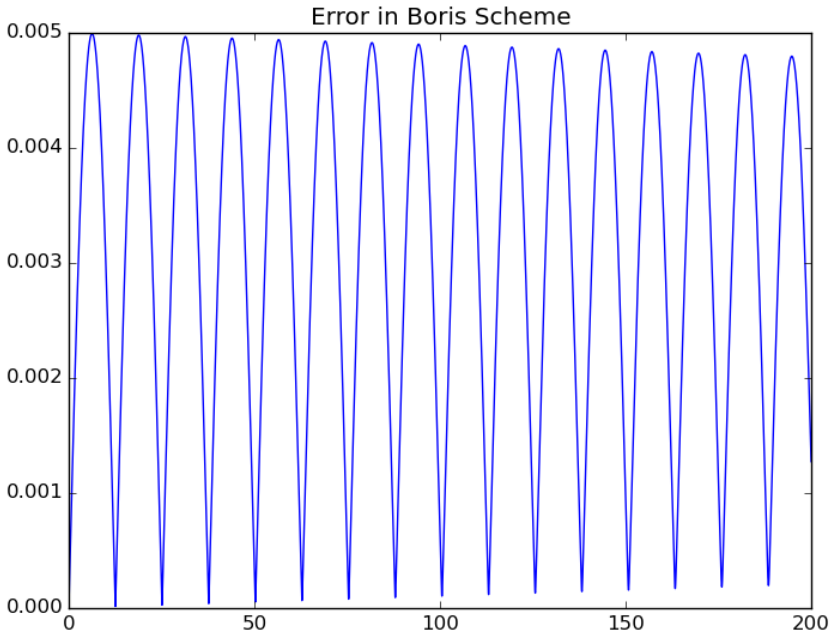


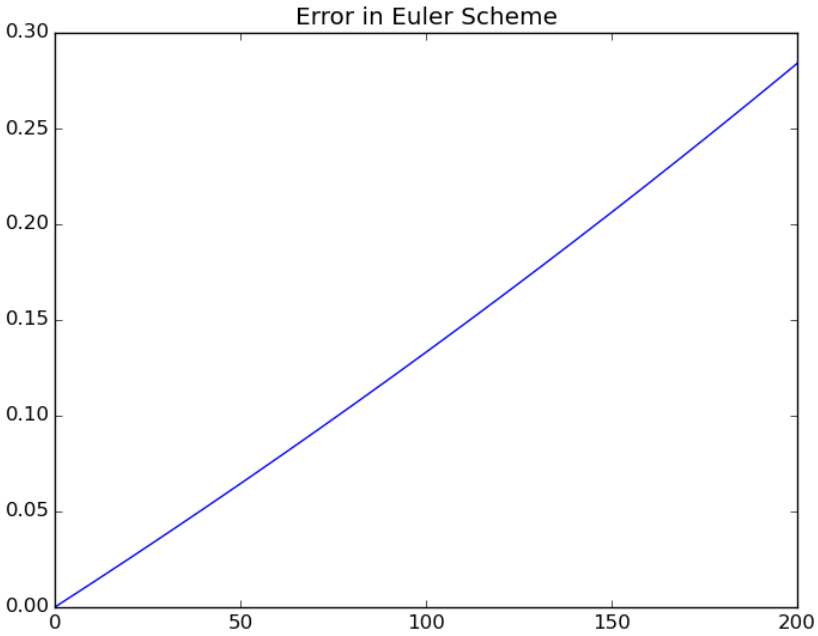

Dissipation of particle using Euler Scheme
1e8
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200

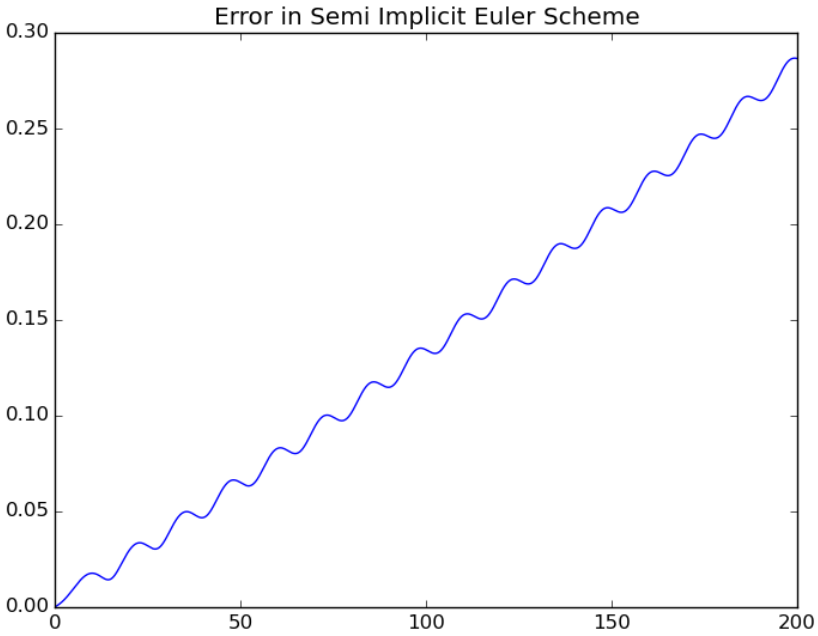

1e8Dissipation of particle using Semi Implicit Euler Scheme
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200

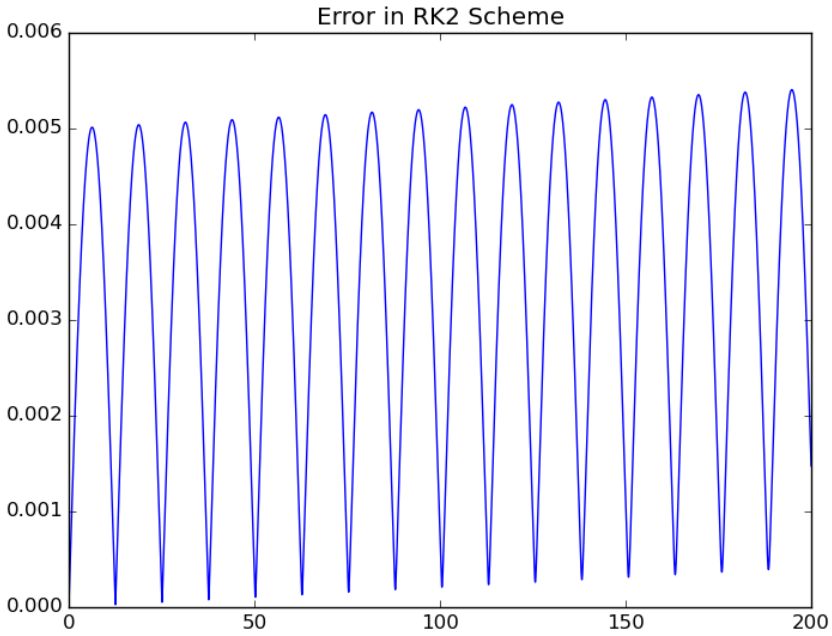



### 1.4 Error in Particle Position with time using Different Schemes



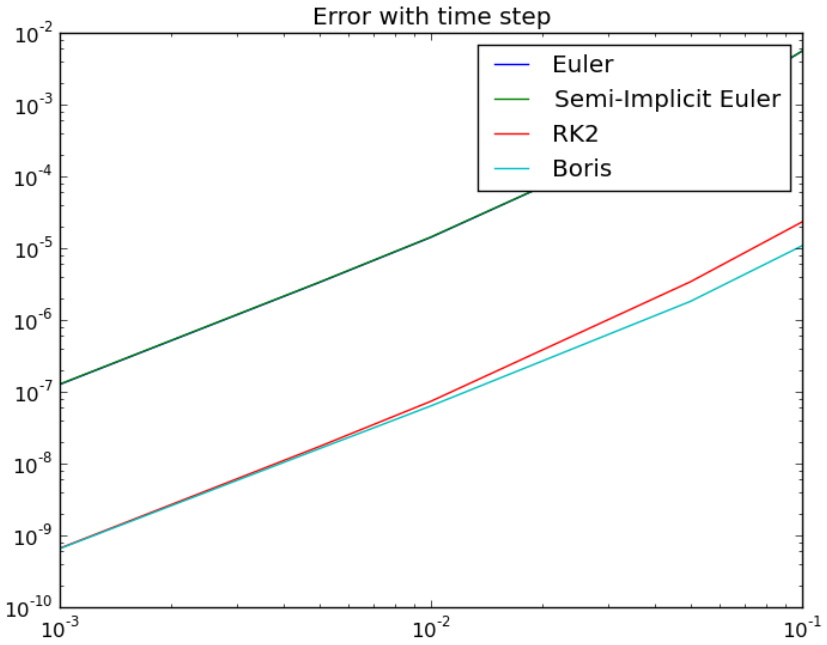

Error in Euler Scheme
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200


Error in Semi Implicit Euler Scheme
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200




## 2 Question 2

Error in different schemes varying with time step size for the constant magnetic field simulation.

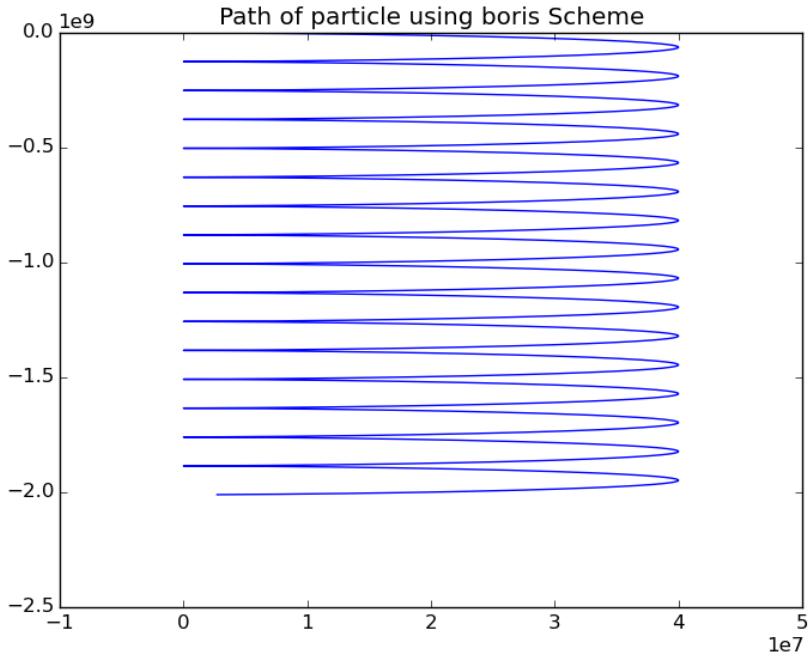


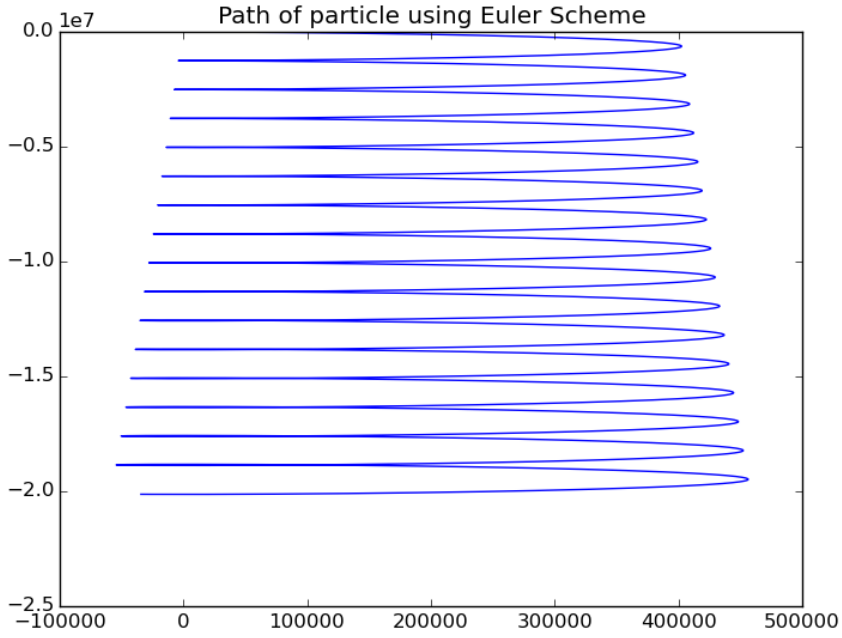

It can be clearly seen that the slope of RK2 is greater than Euler showing the orders of the schemes to be 2 and 1 respectively as the plot is a log log plot.

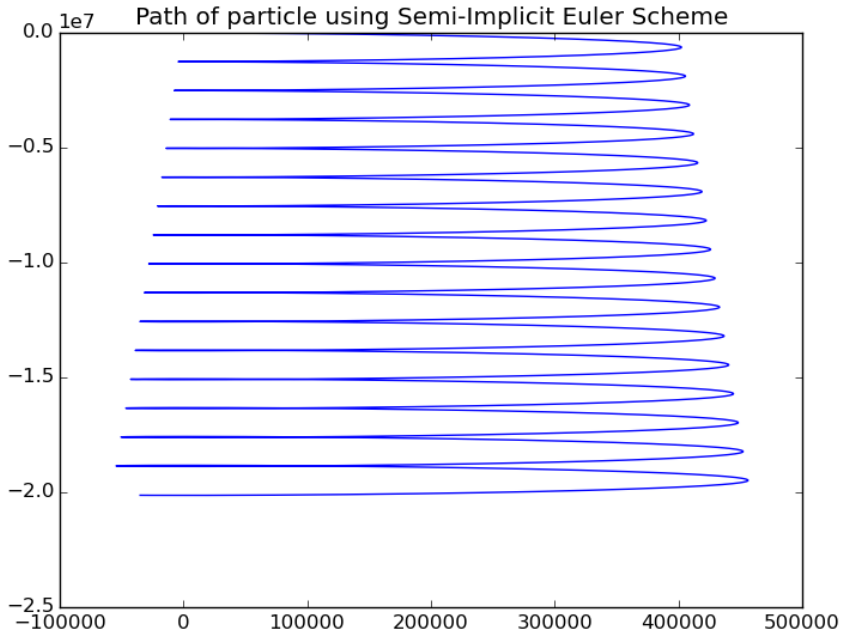
# 3 Question 3

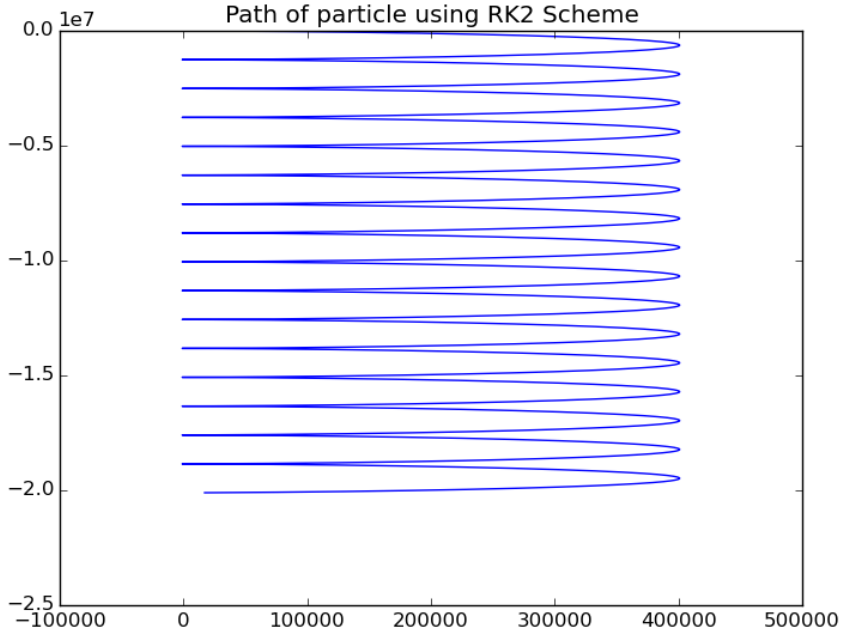
The following plots show the results of motion of a charged particle under the influence of a constant electric field and magnetic field.

### 3.1 Paths using Different Schemes

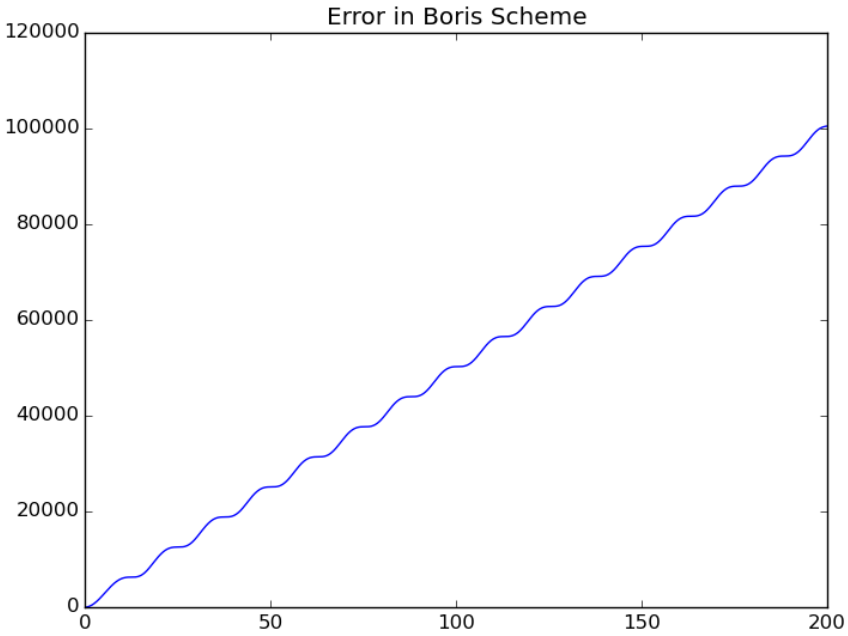


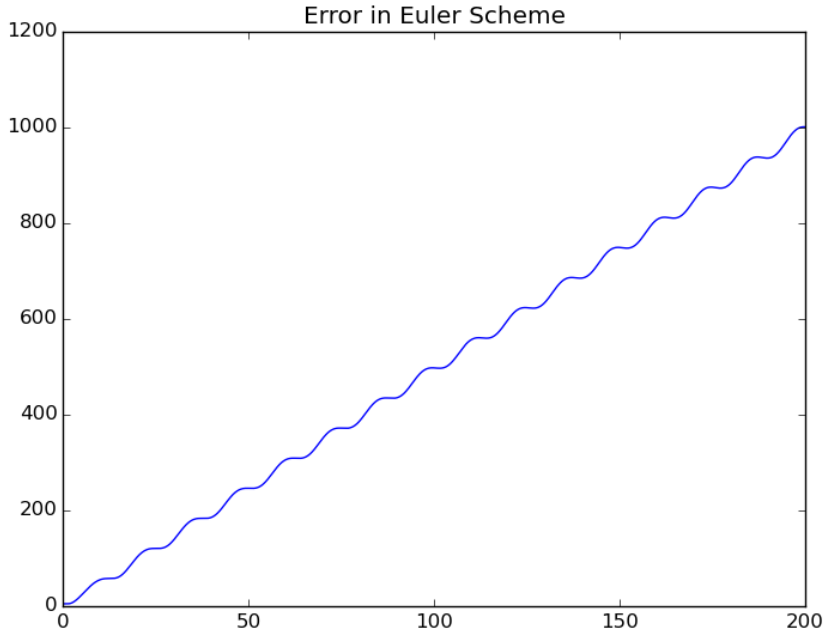



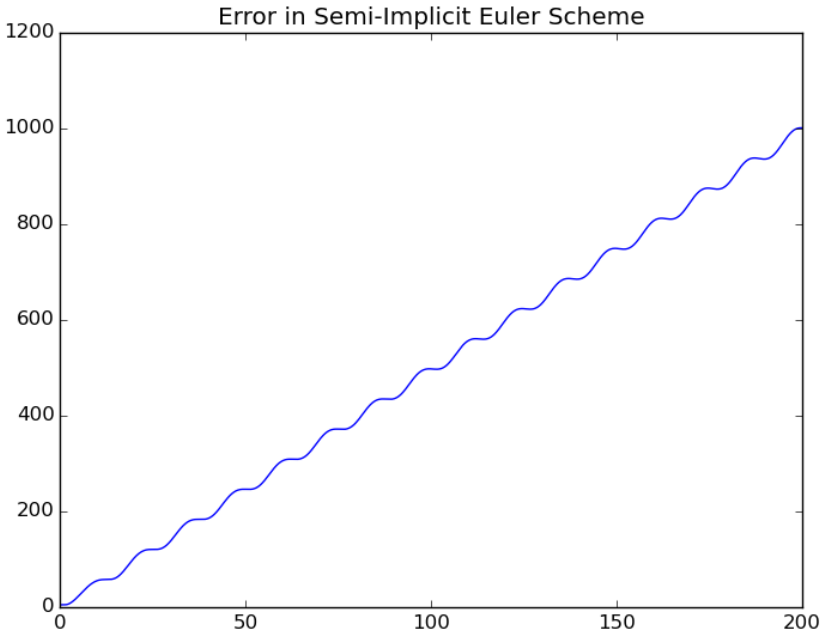

Path of particle using Semi-Implicit Euler Scheme
1e7
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−100000
0
100000
200000
300000
400000
500000

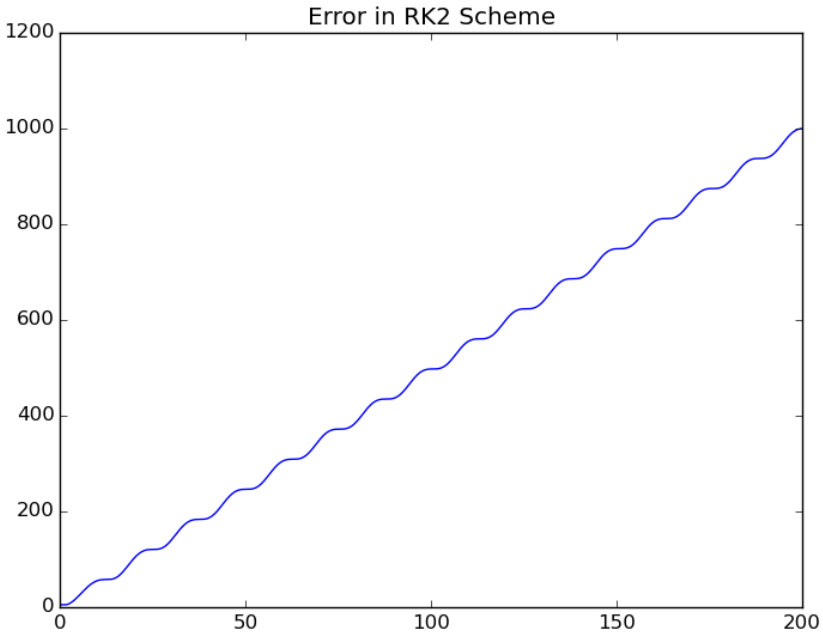

Path of particle using RK2 Scheme
1e7
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−100000
0
100000
200000
300000
400000
500000

### 3.2 Error in Particle Position with time using Different Schemes



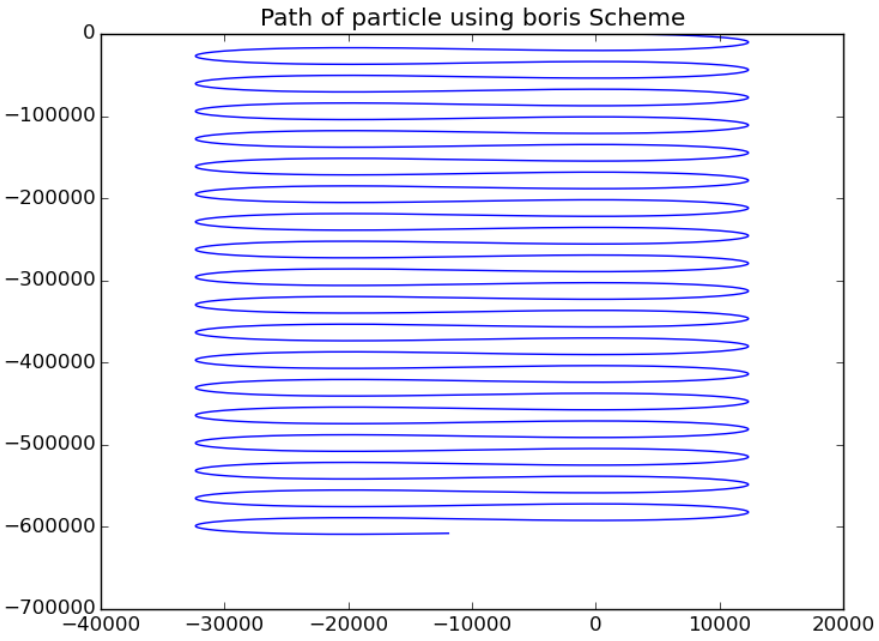

Error in Semi-Implicit Euler Scheme
1200
1000
800
600
400
200
0
0
50
100
150
200

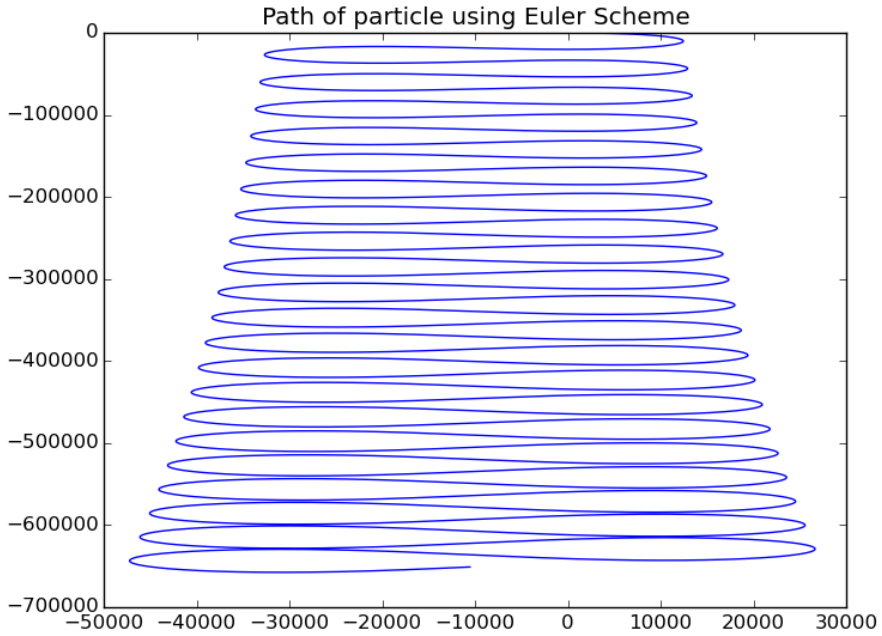

Error in RK2 Scheme
1200
1000
800
600
400
200
0
0
50
100
150
200

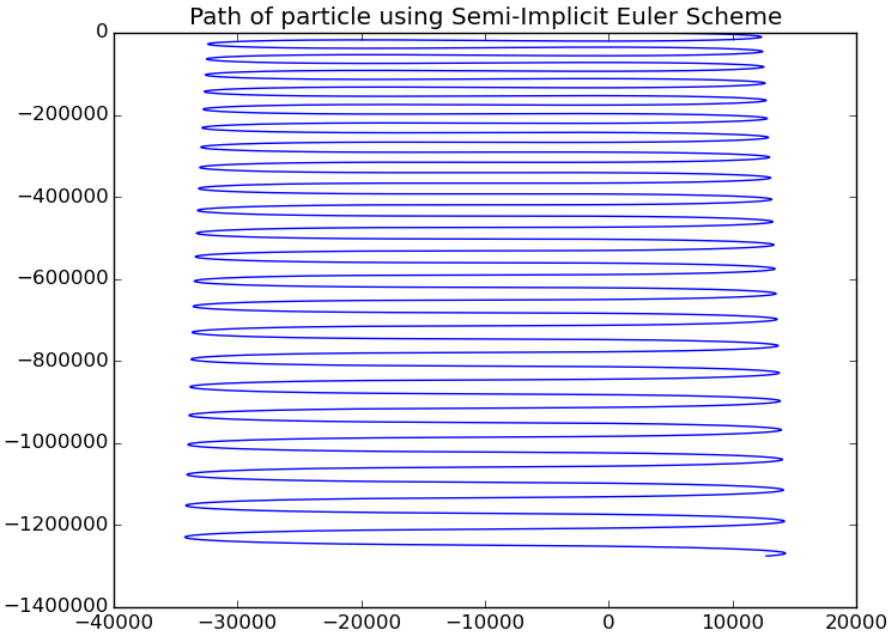
# 4 Question 4

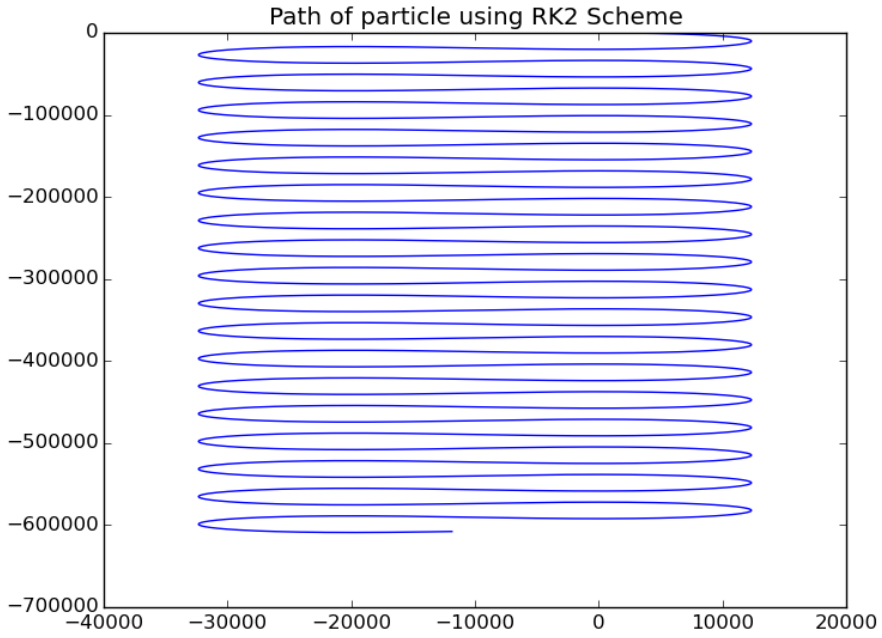
The following plots show the results of motion of a charged particle under the influence of a zero electric field and constant gradient magnetic field whose z-component's gradient is constant along x-axis.

## 4.1 Paths using Different Schemes

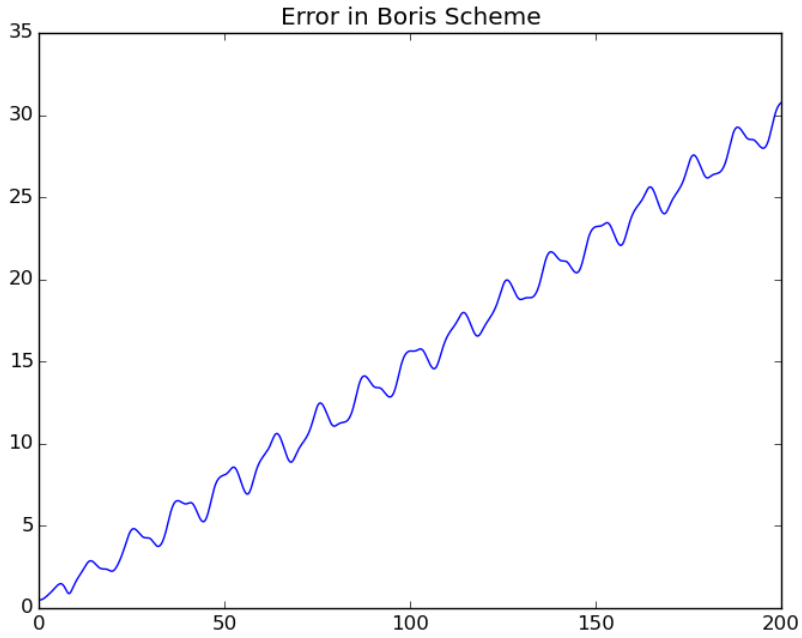


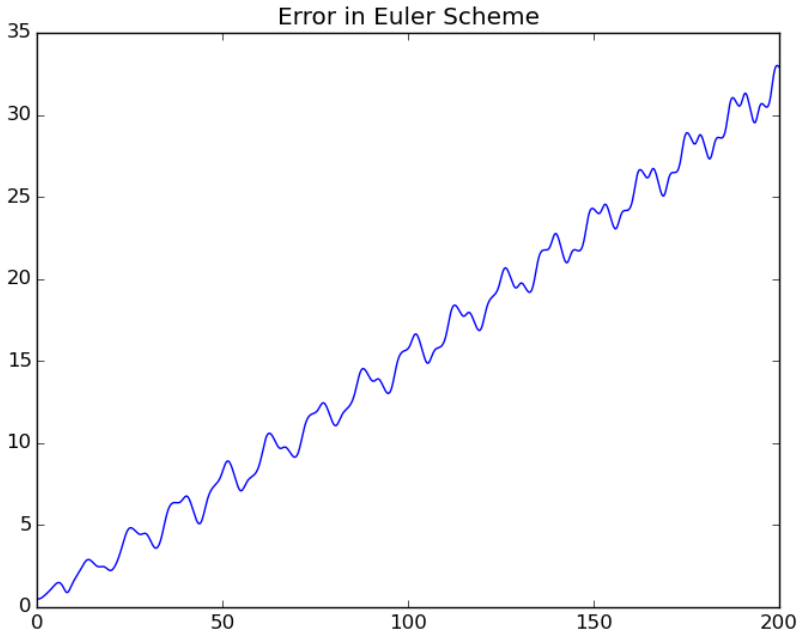

Path of particle using Euler Scheme
0
−100000
−200000
−300000
−400000
−500000
−600000
−700000
−50000
−40000
−30000
−20000
−10000
0
10000
20000
30000

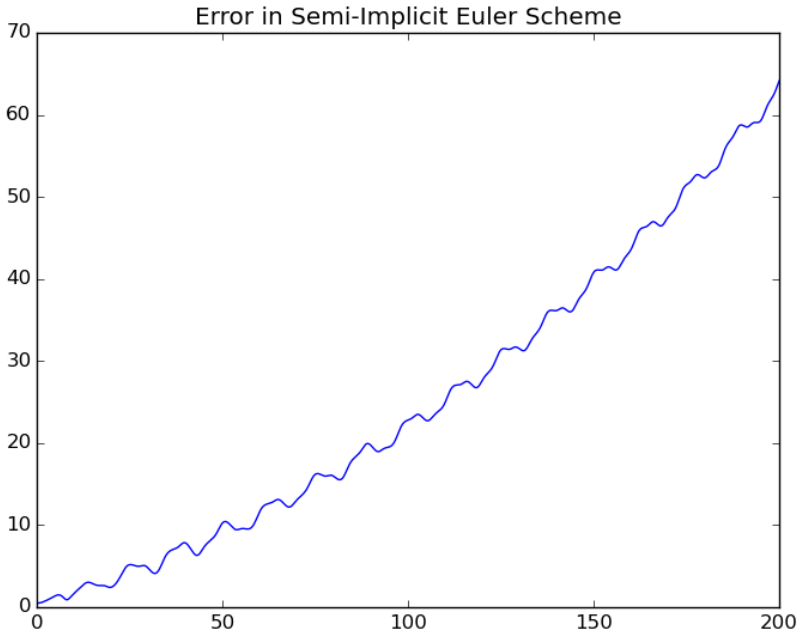

Path of particle using Semi-Implicit Euler Scheme
0
−200000
−400000
−600000
−800000
−1000000
−1200000
−1400000
−40000
−30000
−20000
−10000
0
10000
20000

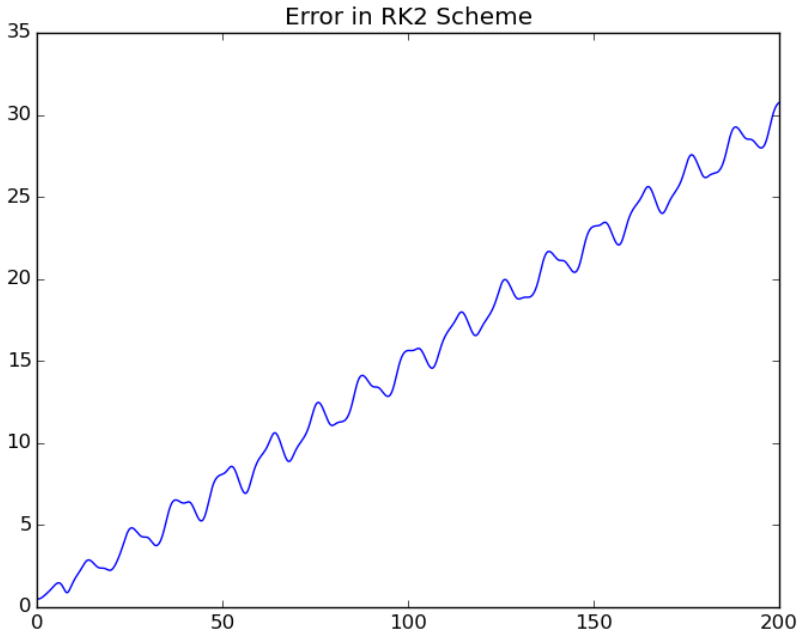



## 4.2 Error in Particle Position with time using Different Schemes




Error in Euler Scheme
35
30
25
20
15
10
5
0
0
50
100
150
200


Error in Semi-Implicit Euler Scheme
70
60
50
40
30
20
10
0
0
50
100
150
200


Error in RK2 Scheme
35
30
25
20
15
10
5
0
0
50
100
150
200