Exercise 5

Introduction to Computational Astrophysics, SoSe 2024

Seha Lee

Task 1. *Euler method for the harmonic oscillator*

Solution. (a) The result is shown in 1. □

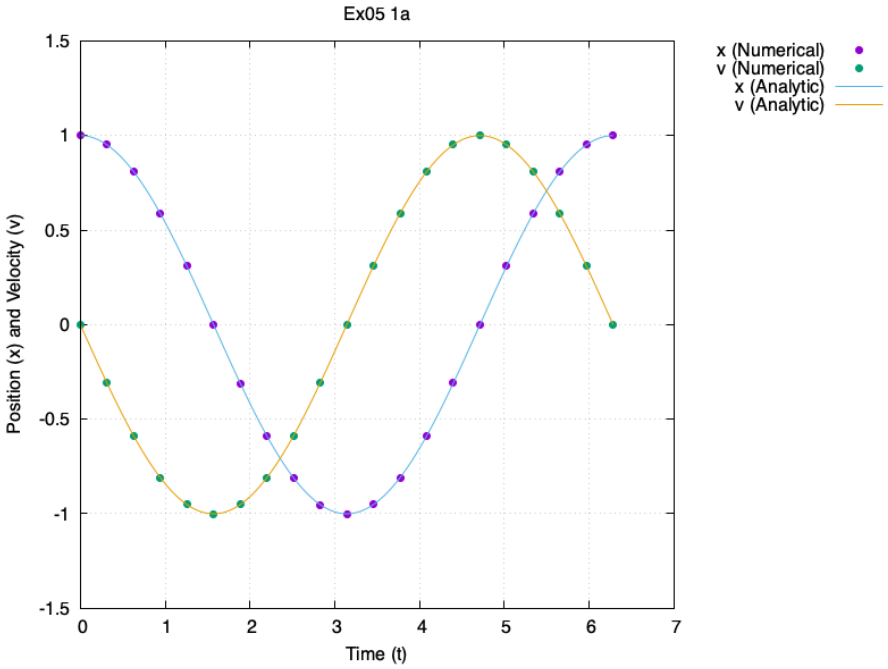


Figure 1: Task 1(a)

Solution. (b) It can be observed that the calculation using Euler method start to deviate from the analytic solution. □

Solution. (c) The calculation using Euler-Cromer method, which is shown with yellow dots, is closer to the analytic solution than that of Euler method. □

Task 2. *The Kepler problem*

Solution. (a) The equations for x and y are coupled by the term $r = \sqrt{x^2 + y^2}$. □

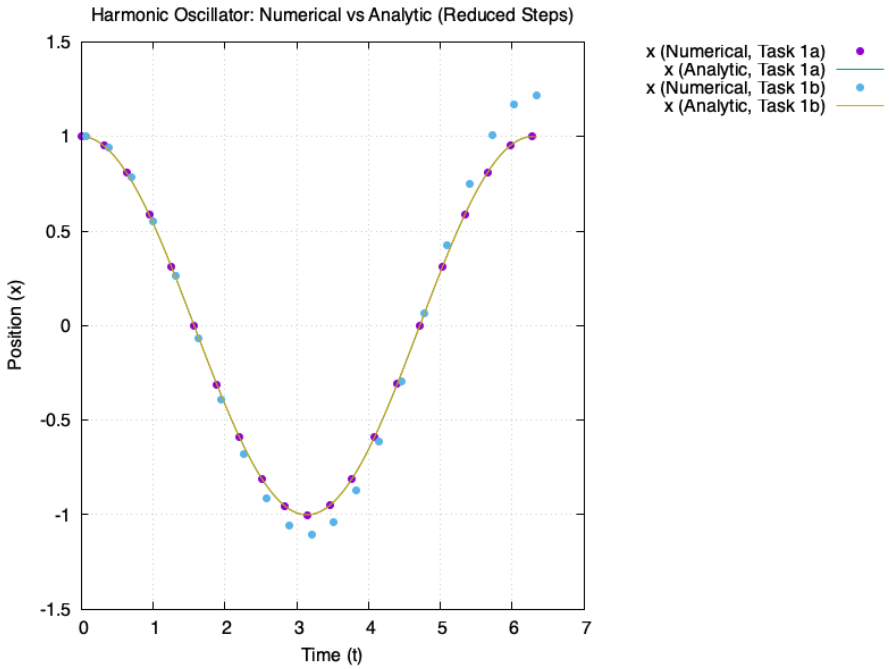


Figure 2: Task 1(b)

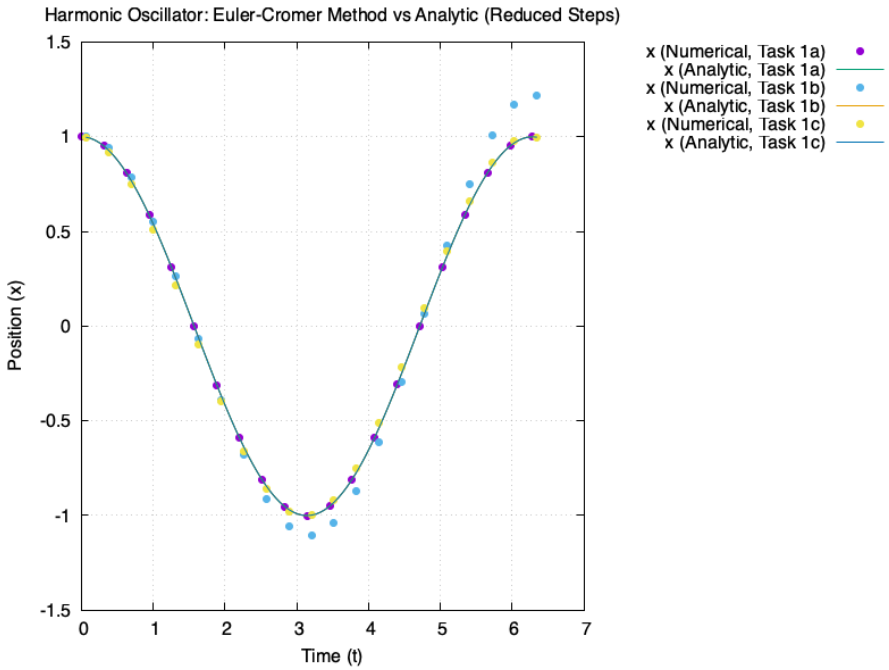


Figure 3: Task 1(c)

Solution. (a) & (b) See attached source code. □

Solution. (c) & (d) The time step size should be at least 0.01 for Euler-Cromer method and 0.00001 for Euler method. □

Solution. The Euler-Cromer method is better in conserving the energy. □

All the executable files from the source code are named as "output"(or in a similar way).

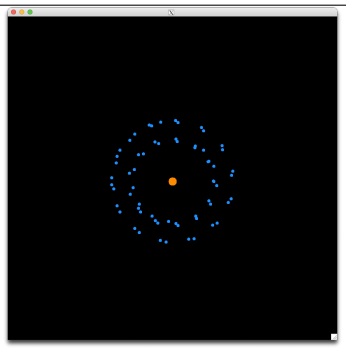
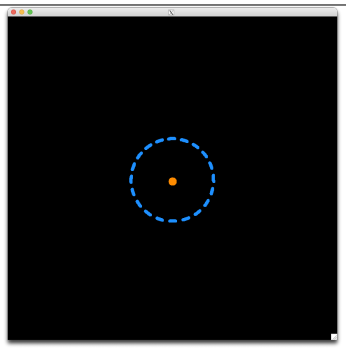
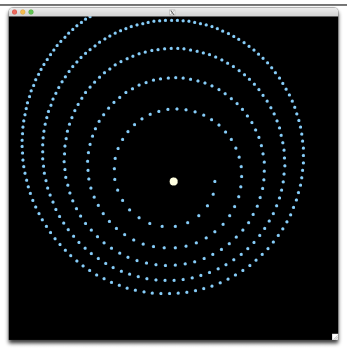
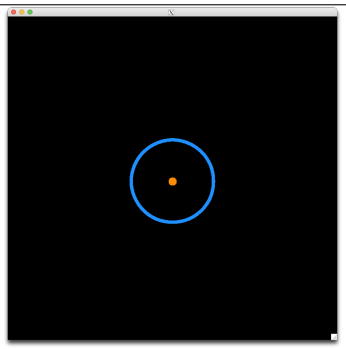
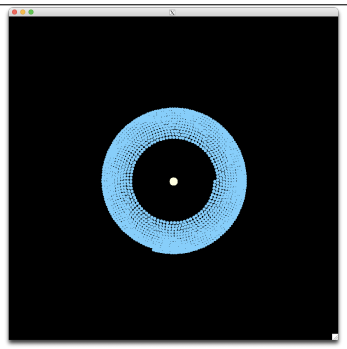
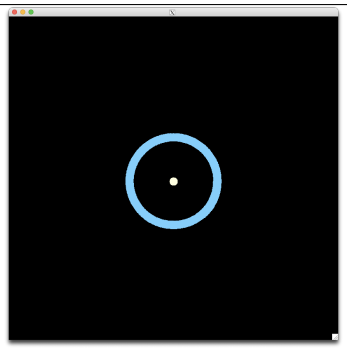
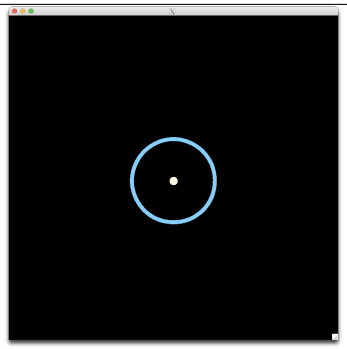
dt	nout	2(c) Euler-Cromer	2(d) Euler
0.1	3		x
0.01	5		
0.001	13		
0.0001	30	x	
0.00001	100	x	

Table 1: Task 2 (c) & (d)

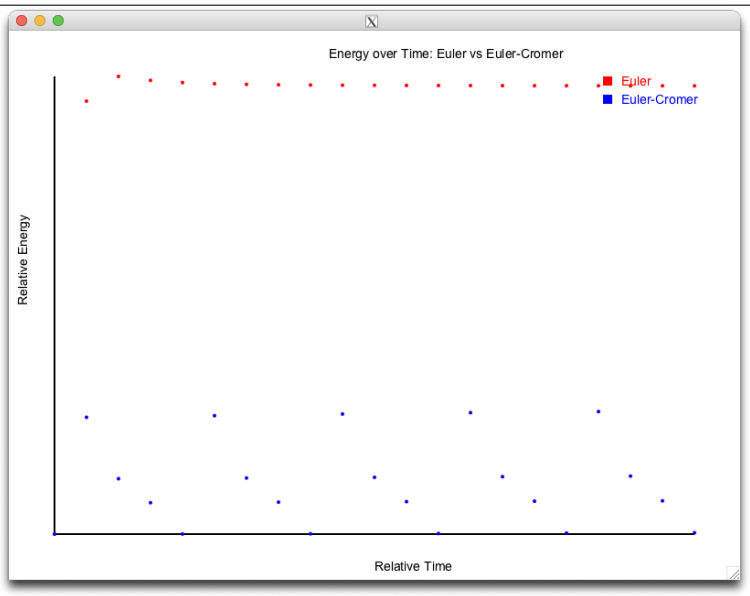
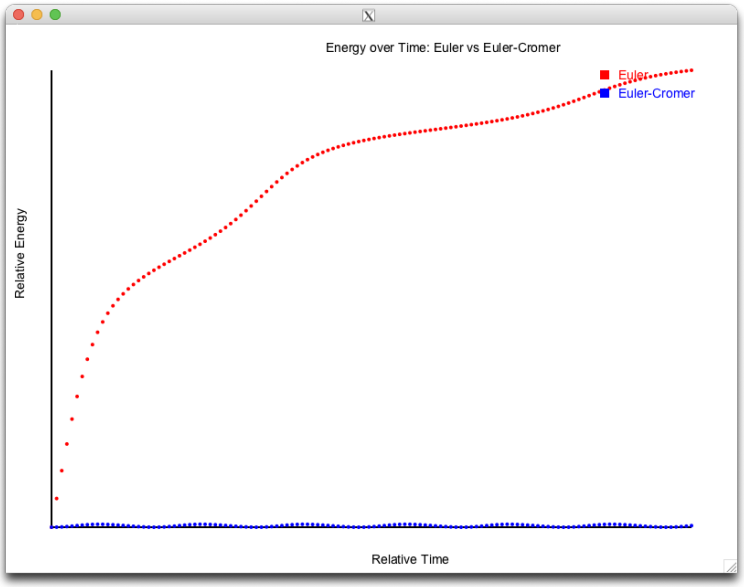
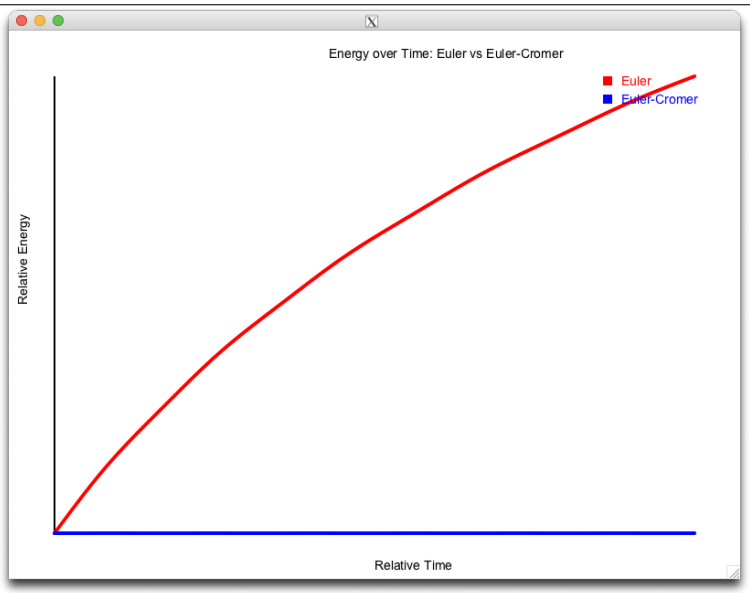
dt	nout	Comparison
0.1	3	
0.01	5	
0.001	13	

Table 2: Task 2 (e)