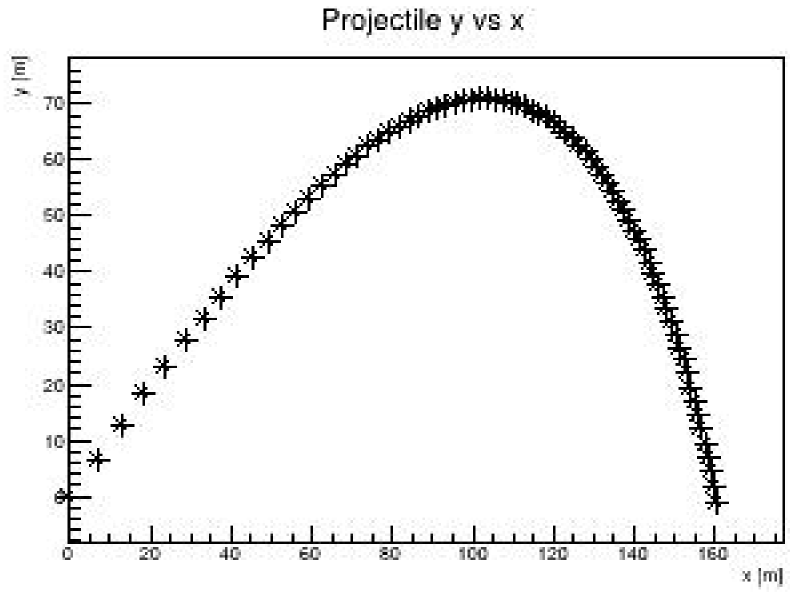
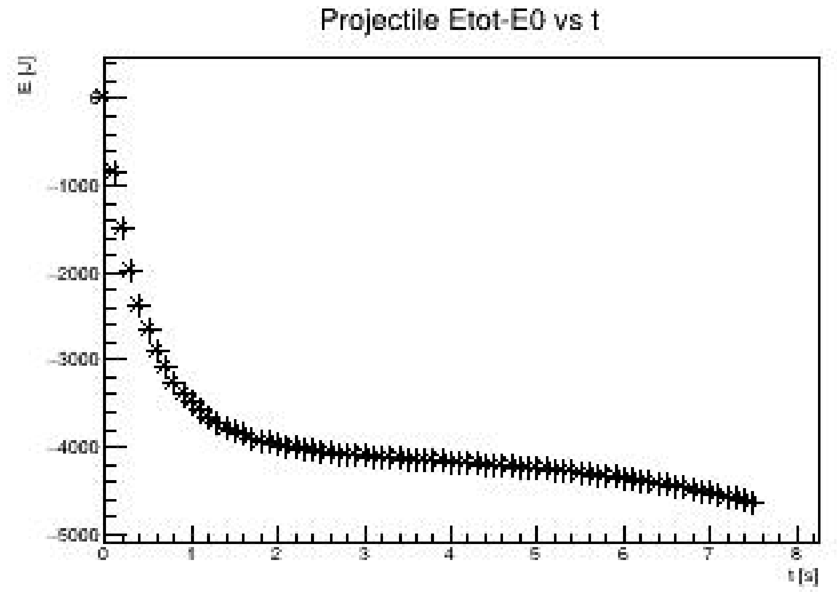
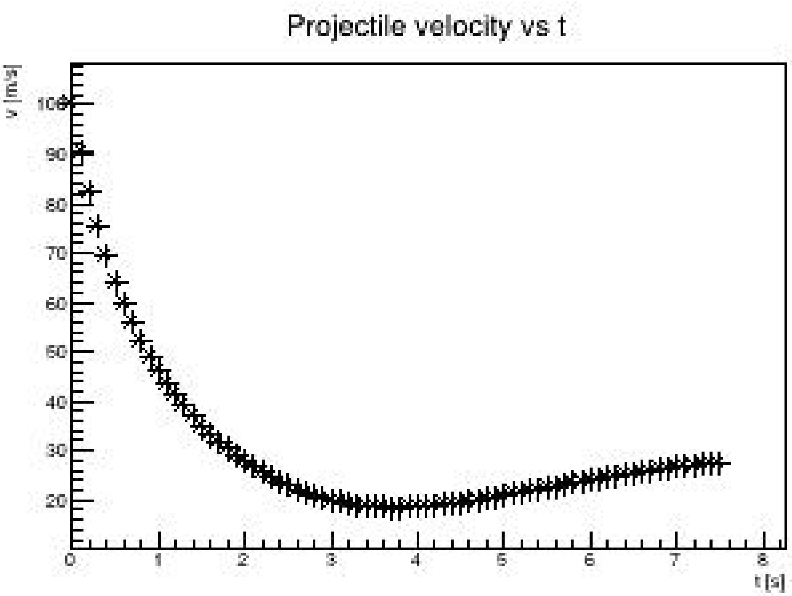
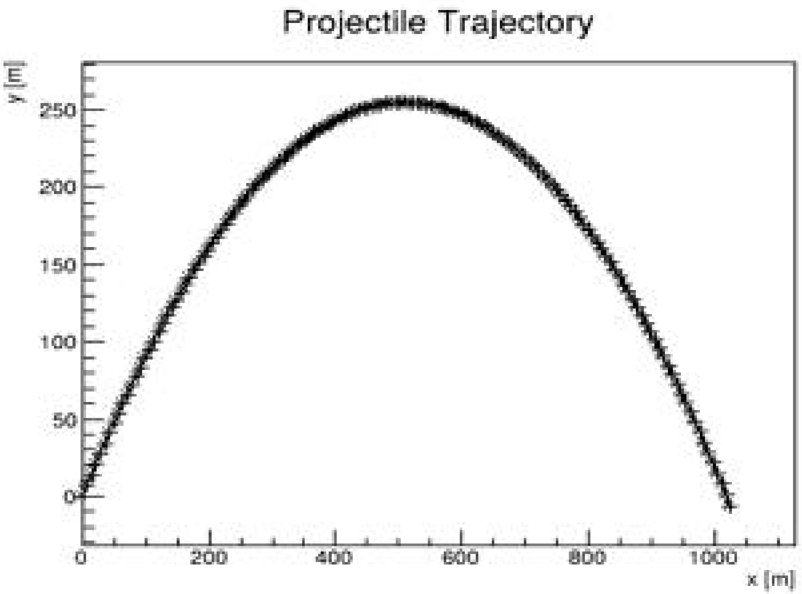
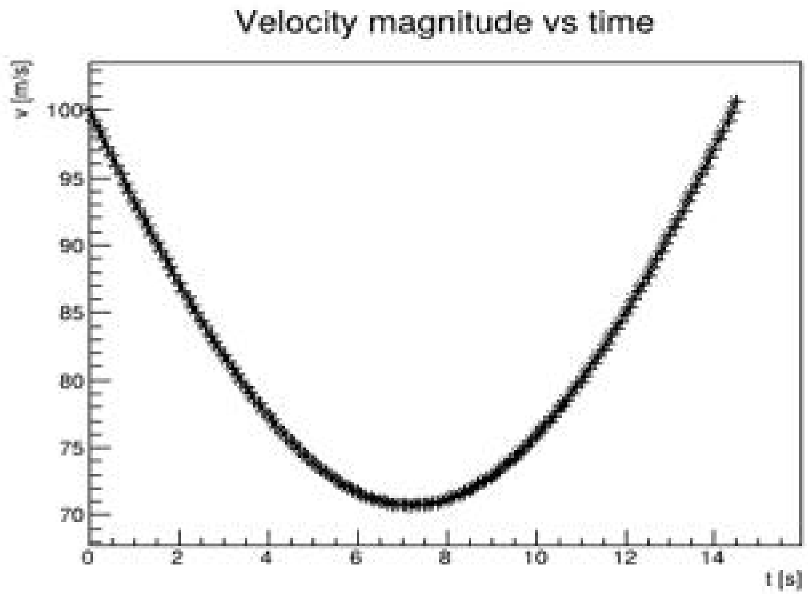
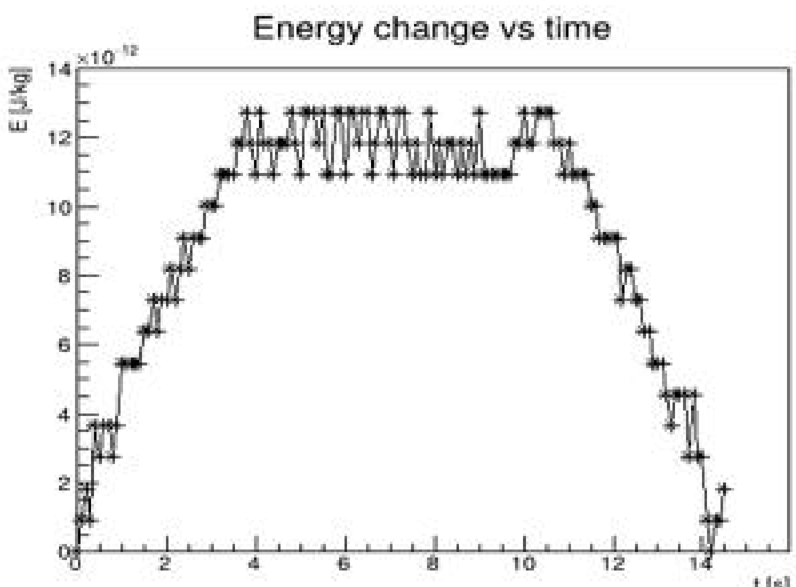

Projectile y vs x
y [m]
x [m]
0
10
20
30
40
50
60
70
0
20
40
60
80
100
120
140
160

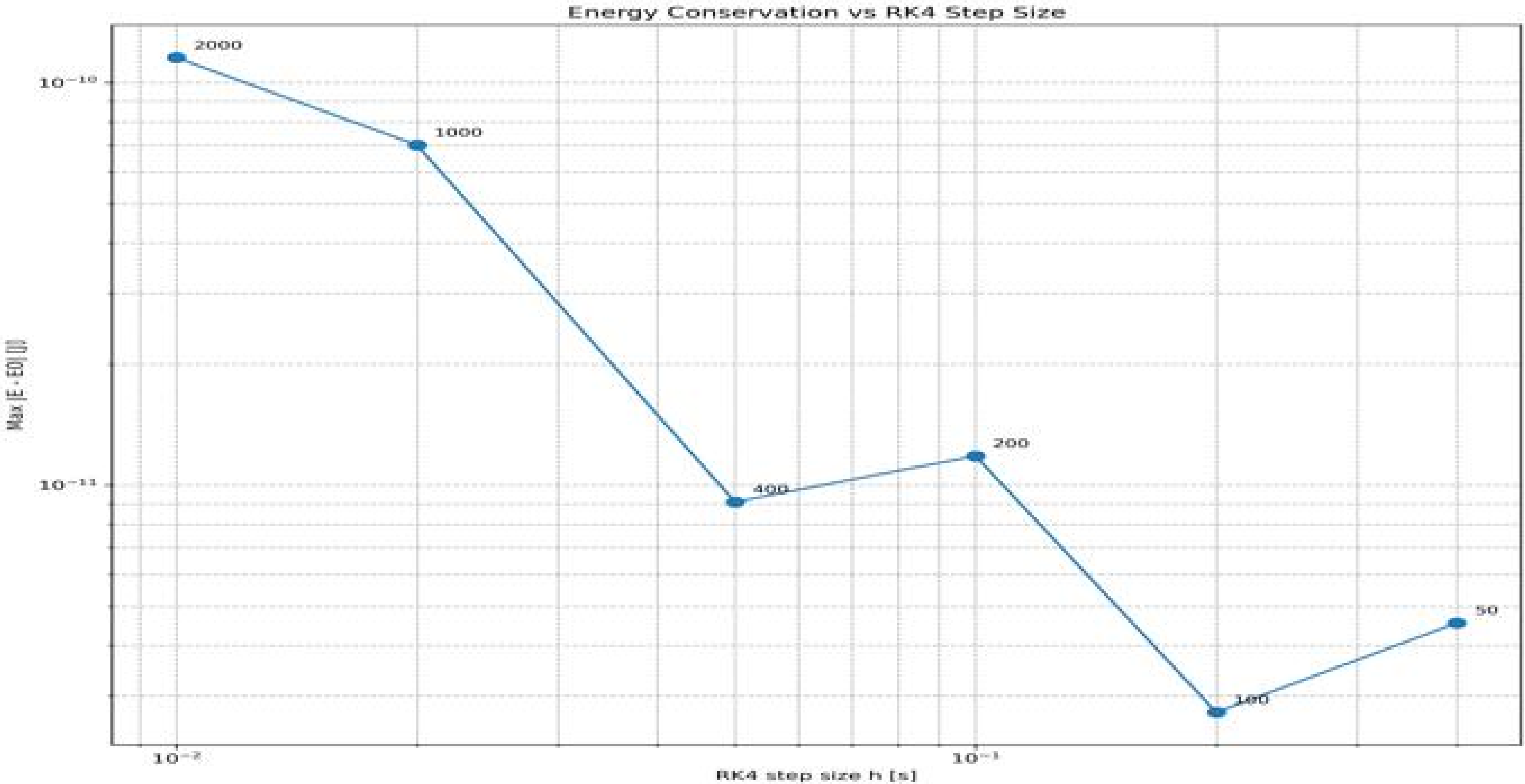

Projectile Etot-E0 vs t
E [J]
t [s]
0
-1000
-2000
-3000
-4000
-5000
0
1
2
3
4
5
6
7
8


Projectile velocity vs t
v [m/s]
t [s]
100
90
80
70
60
50
40
30
20
0
1
2
3
4
5
6
7
8

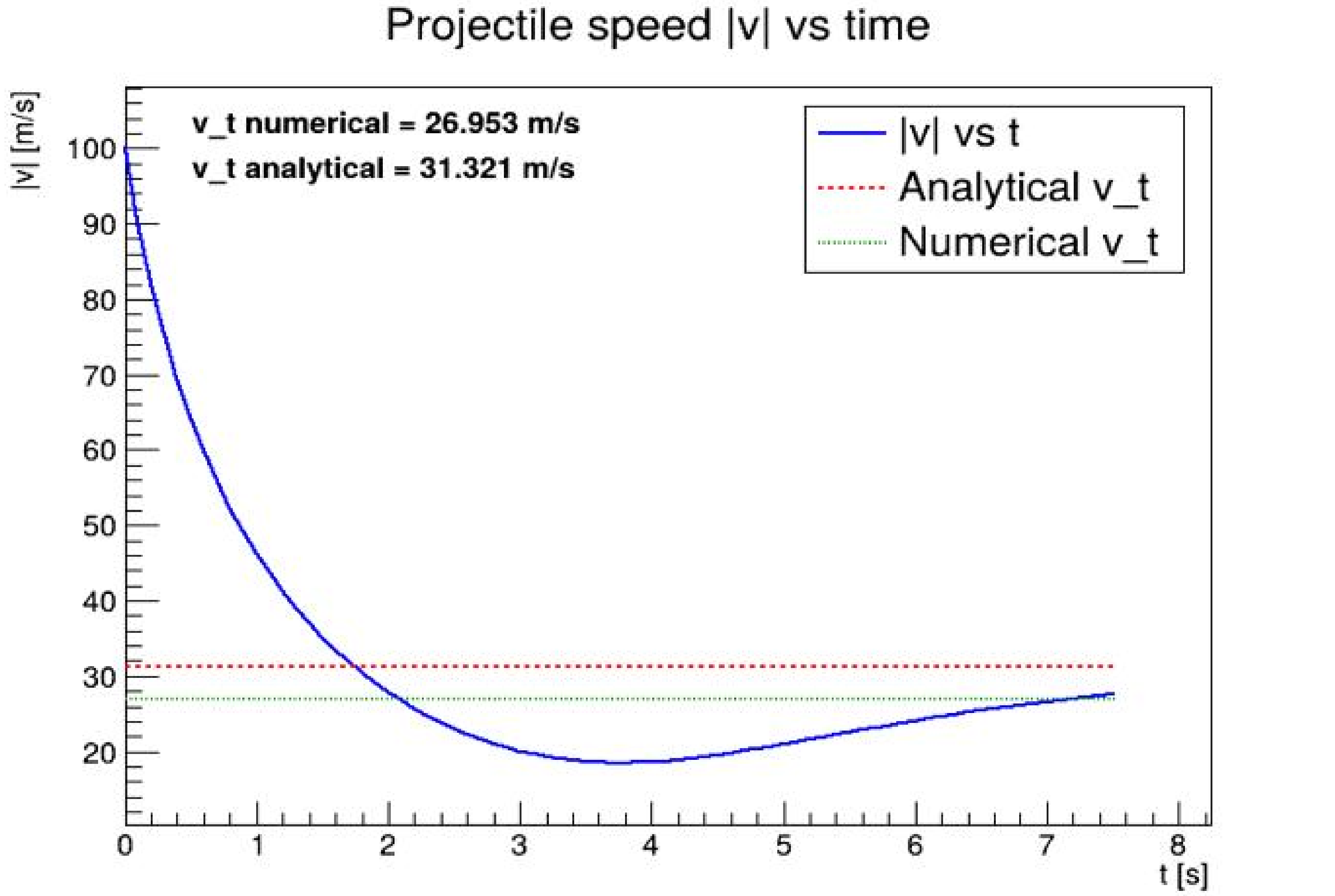

Projectile Trajectory
y [m]
x [m]
0
50
100
150
200
250
0
200
400
600
800
1000


Velocity magnitude vs time
v [m/s]
t [s]
70
75
80
85
90
95
100
0
2
4
6
8
10
12
14

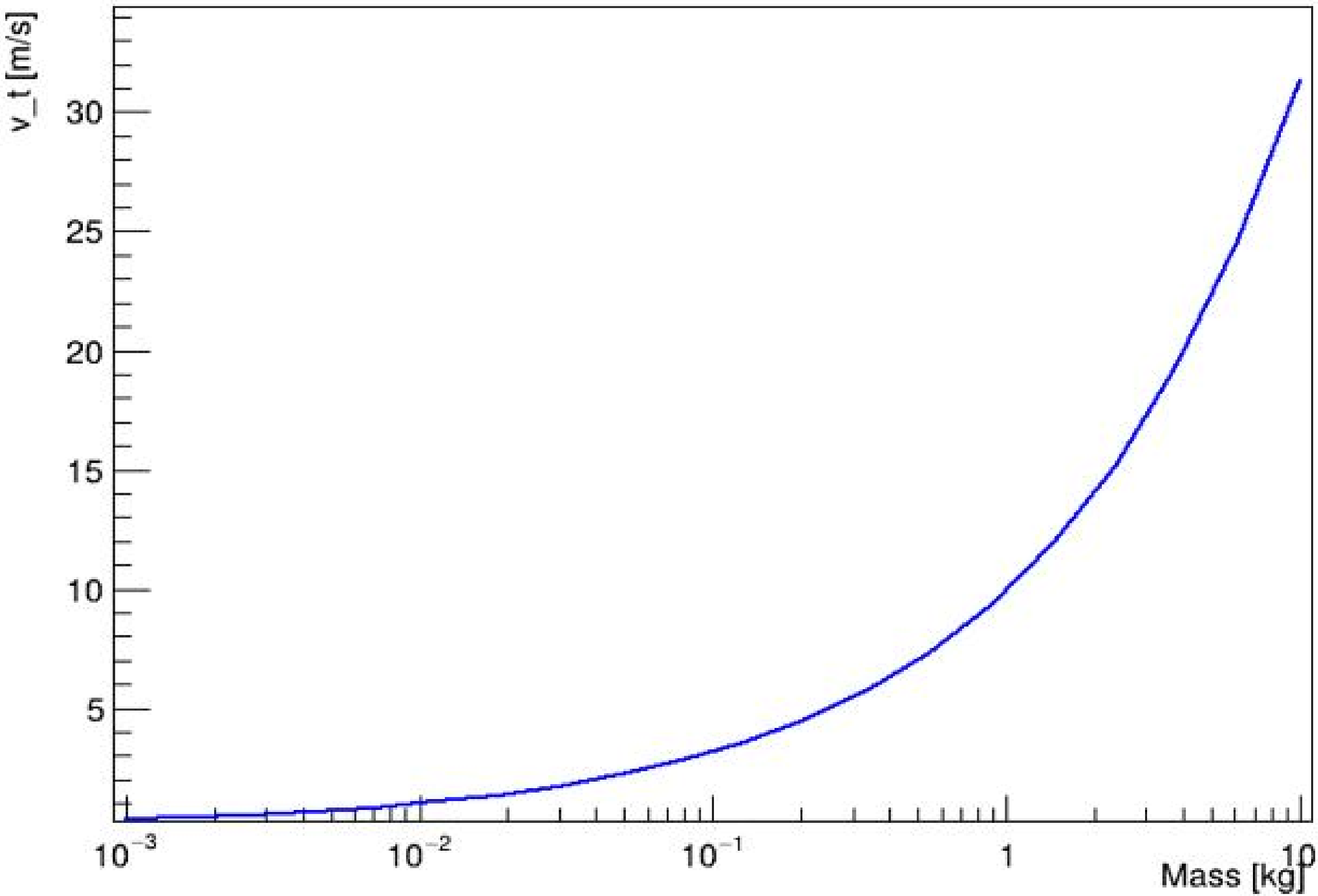

Energy change vs time
E [J/kg]
×10⁻¹²
t [s]
0
2
4
6
8
10
12
14
0
2
4
6
8
10
12
14



--- Energy Conservation Analysis ---
Step sizes ranged from 0.0100s to 0.4000s
Maximum energy deviation with largest step: 0.000000 J
Maximum energy deviation with smallest step: 0.000000 J
Observation:
- Energy is very well conserved for small step sizes.
- Larger step sizes produce larger numerical deviations.
- Reducing RK4 step size improves accuracy, consistent with 4th-order convergence.


Projectile speed |v| vs time
v_t numerical = 26.953 m/s
v_t analytical = 31.321 m/s
|v| vs t
Analytical v_t
Numerical v_t
|v| [m/s]
t [s]
100
90
80
70
60
50
40
30
20
0
1
2
3
4
5
6
7
8

Analytical Terminal Velocity vs Mass



Evaluation of the Accuracy of Projectile Motion with Air Resistance

1. Terminal Velocity Check:
   - Numerical velocities asymptotically approach analytical v_t = sqrt(m*g/k).

2. Step Size Convergence:
   - Decreasing RK4 step size leads to consistent results.
   - Confirms solver stability and 4th-order convergence.

3. Energy Considerations:
   - Total mechanical energy decreases smoothly due to drag.
   - No unphysical jumps or increases.

4. Directionality:
   - Drag opposes motion as expected.
   - Velocities reduce toward terminal value along trajectory.

5. Limiting Cases:
   - No air resistance reproduces standard parabolic trajectory.
   - Extreme mass limits reproduce correct scaling: v_t ~ sqrt(m).

Conclusion:
- Numerical solutions with air resistance behave as physically expected.
- Convergence, smooth energy loss, correct limiting cases, and terminal velocity agreement p