Course and Section_____ Names: _____

Date. _____ _____

KINEMATICS SIMULATION

Introduction

In this simulation you will study motion in one and two dimensions. More specifically the relations between position, velocity and acceleration to describe the motion of an object.

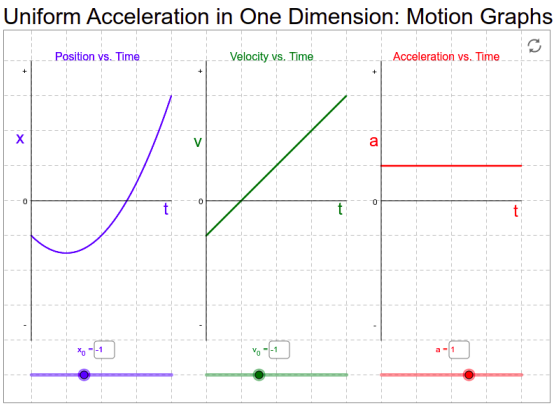
Submit your answers using Blackboard.

1 – Preliminary Questions

1. Are the directions of the displacement and velocity always same ?
2. Are the directions of velocity and acceleration always same ?
3. If the acceleration is zero, does it mean that the object is not moving ?
4. Is it possible for the velocity of an object to be zero and its acceleration not zero ?

2 – Motion Graphs at Constant Acceleration

Open the following simulation (https://ophysics.com/k4.html)



You can change the values of initial position x_0, velocity v_0 and acceleration a_0 using the bar at the bottom.

Answer the following questions by looking at the graphs or by using the kinematic equations (and use the graphs to verify your solution).(Note: For the questions 5-13, use only numerical value; No units)

Set x_0 = -4.0, v_0 = 1 and a_0 = 0
5. What is the position at t = 3?
6. Do the velocity or the acceleration ever change?

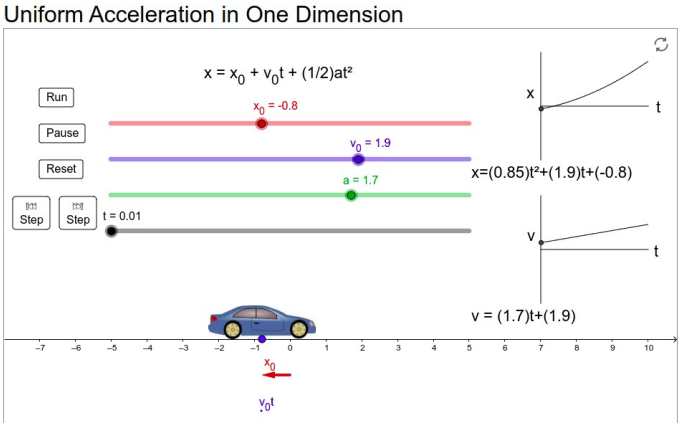
Set x_0 = 3, v_0 = -4 and a_0 = 1
7. At what time does the velocity = 0?
8. At what time the position = -3?

Set x_0 = 4, v_0 = 0 and a_0 = -2
9. What is the velocity at t = 2?
10. At what time is the position = 0?

Set x_0 = 4, v_0 = 1 and a_0 = -1
11. What is the velocity at t = 2?
12. What is the position at t = 2?
13. At what time is the position = 0?

3 – Motion at Constant Acceleration

Open the following simulation (https://ophysics.com/k6.html)

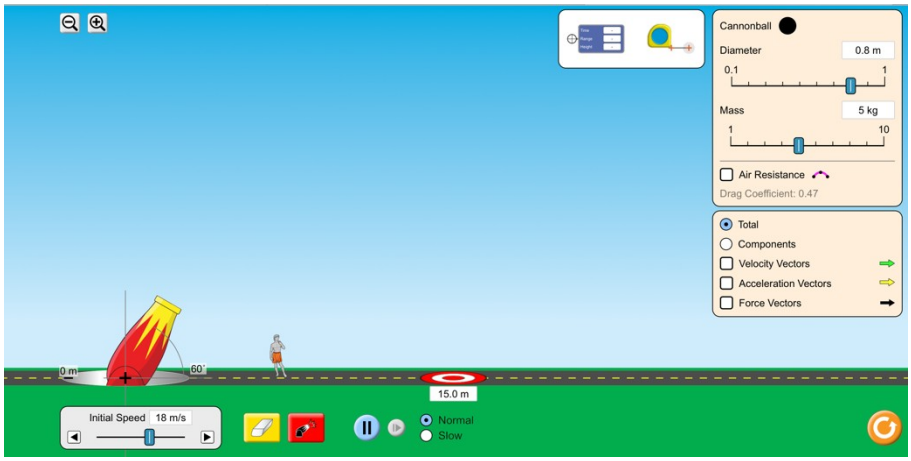


Set x_0 = -4, v_0 = 1 and a_0 = 0
14. What is the position of the car at t = 3?
15. What is the velocity of the car at t = 3?

Set x_0 = -4, v_0 = 3 and a_0 = -0.5
16. What is the velocity of the car at t = 2?
17. What is the velocity of the car at t = 10?
18. What is the position of the car at t = 5?
The car changes its direction at the location x =5
19. If instead v_0 = 2.5 in which location now does the car charges direction?
For the next two questions use a 3 digits answer (you have to make the calculations while the simulation can be used to check).
20. If instead v_0 = 2.27 in which location now does the car charges direction?
21. Which v_0 will make the car change its direction at x = 4?

4 – Projectile motion

Open the simulation (https://phet.colorado.edu/en/simulation/projectile-motion) and select *Vector.* Uncheck the 'Air Resistance' for this entire simulation. Set the Initial Speed to 15 m/sec, Mass 4 kg, Diameter 1.0 m. You can drag the blue box on the right top corner to any point on the path of projectile to measure time, range and height.



Now, fire the ball at initial angle 45^0.
22. How far did it go?
23. What is the time of flight?
24. What height did it reach?

Fire the ball again but now select Slow motion
25. Which components of the velocity are constant?
26. What is the value of y-component of velocity at maximum height?
27. What is the value of x-component of velocity?
28. Is the acceleration a constant value?

Now add air resistance.
29. Which components of the velocity are constant?
30. How is the time that it takes to move upward relative to the time it takes to fall down?

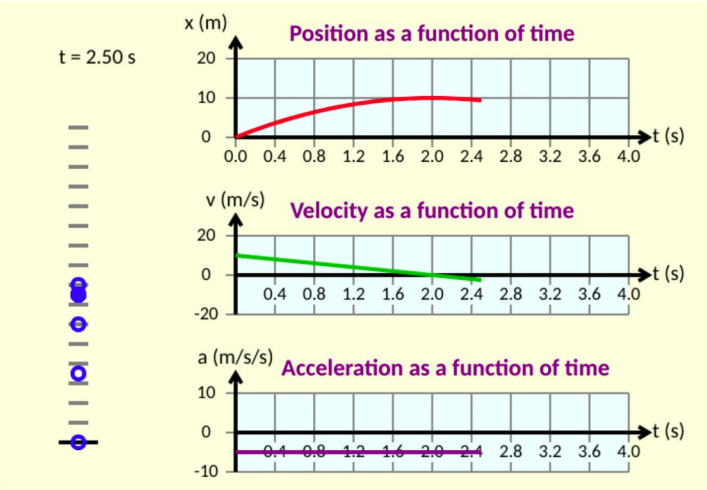
Keep the same initial speed of 15 m/s. (Uncheck air resistance)
31. What is the initial angle for the ball to reach the greatest distance?
32. What is the initial angle for the ball to reach the maximum height?

Keep same initial speed of 15 m/s, set initial angle = 75º
33. Is the time of flight independent of mass of the ball?
34. Is the maximum height independent of the mass of the ball?

There is target on the ground at distance 15.0 m. If you hit the target the simulation shows three stars. If it only shows one star your shot is not precise enough, repeat.
35. If the initial speed is 13 m/s at what angle, smaller than 45º, must the ball be fired to hit the target?
36. If the initial angle is 45° what initial speed is necessary to hit the target?

5 – Free Fall

Open the simulation
(https://pages.physics.ua.edu/lab10x/1mech/SIM/applet/Sim_Free_Fall.html)



Choose "Launch up at 10 m/s". The coordinate x(m) indicates the vertical height. The initial speed is 10 m/s.
Look at the velocity graph and fill out the table below (try your best estimate, three points are quite obvious). Plot the velocity-time graph on Excel (or any program you prefer). Fit it linearly.

Velocity(m/s)							
Time (s)							

37. What physical quantity does the slope represent?
38. What is value of the slope?

If we do theoretical calculations using the given initial conditions above, we get the following data. Plot the velocity-time graph on Excel (or any program you prefer). Fit it linearly.

Velocity(m/s)	10	7.5	5	2.5	0	-2.5	-5
Time (s)	0	0.5	1	1.5	2.0	2.5	3.0

39. What is value of the slope?
40. Find the % error with the result you obtained in question 38 and in 39.

$$\frac{|ApproximateValue - ExactValue|}{|ExactValue|} \times 100\%$$