Name: [redacted]

Date: Tuesday June 27, 2017

Course: PHYS 2211L-Afternoon

Partner: [redacted] & [redacted]

Lab: Lab 5 Parts A-D

Grade: 96 (Filled in by grader)

1) Objective:

a. The goal of this investigation was to get even more familiarized using the "Interactive Physics" program and to get the student skilled at solving 2-D kinematics problems

2) Theory:

a. Students are expected to be able to read the problems and analytically solve the problem in each part using the kinematic equations they learned in their lecture.

b. Variables:

   i. V_f = final velocity
   ii. V_i = initial velocity
   iii. X_f = final position
   iv. X_i= initial position
   v. A = acceleration
   vi. T = time

c. Formulae:

   i. Velocity-Time Equation
      1. $V_f = V_i + at$
   ii. Displacement-Time Equation
      1. $X_f - X_i = V_i t + (1/2)at^2$
   iii. Velocity-Displacement Equation
      1. $V_f^2 = V_i^2 + 2a(X_f - X_i)$
   iv. Displacement-Average Velocity-Time Equation
      1. $X_f - X_i = [(V_i + V_f)/2]t$

3) Procedure:

a. Parts A and B

   i. First, use Interactive Physics to create an identical scenario and compute the values for total time, final position, and final impact speed. These are going to be your experimental values.
   ii. Using hand-drawn diagrams, compute your own values for these same variables
   iii. Compare the accuracy of these values via percent error.

b. Part C

   i. First, compute the two possible shot angles using the given variables.
   ii. Next, use Interactive Physics and the launch angles previously calculated to create an identical scenario and compute the values for times of flight.
   iii. Using your own hand-drawn diagrams, compute your own times of flight
   iv. Compare the accuracy of these values via percent error

c. Part D

   i. First, compute the initial velocity of the melon using the given variables.
   ii. Next, use Interactive Physics and the initial velocity previously calculated to create an identical scenario and compute the values for total time and the y-value at where the arrow strikes the melon.
   iii. Using your own hand drawn diagrams, compute your own values for total time and the y-value at which the arrow strikes the melon.
   iv. Compare the accuracy of these values via percent error

4) **Data:** *(attached to the back of this report)*

5) **Calculations:** *(attached to the back of this report)*

6) **Results:**

a. Part A

Variable	Experimental	Theoretical	Percent Error
Total Time (s)	4.40 s	4.41 s	**.23%**
Final Position (m)	124.04 m	124.36 m	**.26%**
Impact Speed (m/s)	43.32 m/s	43.38 m/s	**.14%**

b. Part B

Variable	Experimental	Theoretical	Percent Error
Total Time (s)	2.32 s	2.315 s	**.22%**
Final Position (m)	64.83 m	65.28 m	**.69%**
Impact Speed (m/s)	43.26 m/s	43.37 m/s	**.25%**

c. Part C

Variable	Experimental	Theoretical	Percent Error
Flight Time 1 (s)	.700 s	.686 s	**2.0%**
Flight Time 2 (s)	4.80 s	4.81 s	**.21%**

d. Part D

Variable	Experimental	Theoretical	Percent Error
Final Height (m)	7.17 m	7.05 m	**1.7%**
Time (s)	.525 s	.522 s	**.57%**

7) **Analysis:**
   a. In conclusion, I maintained to yield an extremely low percent error throughout the investigation. I was able to easily, yet precisely, calculate the approximate missing values for each part in this lab. In fact, I only went above a 1% error twice throughout all of the parts and averaged around a .25%.
8) **Comments:**
   a. My lab partners and I worked very well and efficiently this lab to get everything done with ease. This lab helped me perfect my kinematics problem solving skills.

Lab 5: Projectile Motion

LONE FORMAT: DUE TUES. JUNE 27.

A

experimentals:

$t = 4.40s$

$x_f = 124.04m$

$v_f =$ ~~[illegible]~~

~~[illegible]~~

43.32 m/s

Part A:

A ball is thrown with a speed of 30 m/s and at an angle of 20° above the horizontal from a 50 m tall bulding.

a. Find the total time in that the ball spent in the air.

b. How far from the base of the building did it land?

c. Find the impact speed of the ball.

Theoretical: Find the above theoretical values.

Experiment: Set up in Interactive physics and find values and % error.

B

experimentals:

$t = 2.32s$

$x_f = 64.83m$

$v_f =$ ~~[illegible]~~

43.26 m/s

Part B:

A ball is thrown with a speed of 30 m/s and at an angle of 20° below the horizontal from a 50 m tall bulding.

a. Find the total time in that the ball spent in the air.

b. How far from the base of the building did it land?

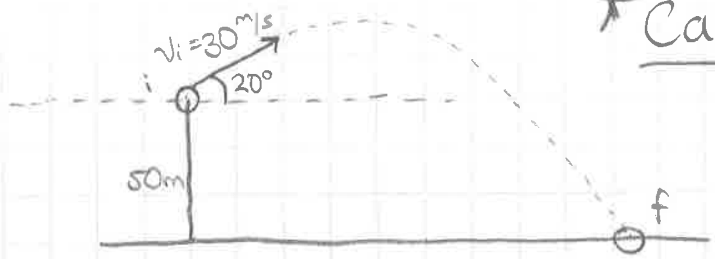
c. Find the impact speed of the ball.

Theoretical: Find the above theoretical values.

Experiment: Set up in Interactive physics and find values and % error.

*Calculations :

Part A :



x-comp:

$x_i = 0$

$x_f = x_f$

$v_{ix} \rightarrow 28.2\,m/s$

$v_{fx} \nearrow$

$a = 0\,m/s^2$

$t = t$

y-comp:

$y_i = 50\,m$

$y_f = 0\,m$

$v_{iy} = 10.26\,m/s$

$v_{fy} = v_{fy}$

$a = -9.8\,m/s^2$

$t = t$

$$y_f - y_i = v_{iy}t + \frac{1}{2}at^2$$

$$-50 = 10.26t - 4.9t^2$$

$$4.9t^2 - 10.26t - 50 = 0$$

$$t = 4.41\,s \quad (a)$$

$$x_f - x_i = v_{ix}t + \frac{1}{2}at^2$$

$$x_f = 28.2(4.41)$$

$$x_f = 124.362\,m \quad (b)$$

$$v_{fy} = v_{iy} + at$$

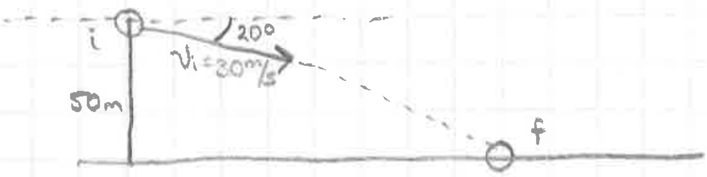
$$v_{fy} = 10.26 - 9.8(4.41)$$

$$v_{fy} = -32.958\,m/s$$

$$\sqrt{28.2^2 + (-32.958)^2} = |v_f|$$

$$43.376\,m/s = v_f \quad (c)$$

Part B :



x-comp:

$x_i = 0$

$x_f = x_f$

$v_{ix} \rightarrow 28.2\,m/s$

$v_{fx} \nearrow$

$a = 0\,m/s^2$

$t = t$

y-comp:

$y_i = 50\,m$

$y_f = 0\,m$

$v_{iy} = -10.26\,m/s$

$v_{fy} = v_{fy}$

$a = -9.8\,m/s^2$

$t = t$

$$y_f - y_i = v_{iy}t + \frac{1}{2}at^2$$

$$-50 = -10.26t - 4.9t^2$$

$$4.9t^2 + 10.26t - 50 = 0$$

$$t = 2.315\,s \quad (a)$$

$$x_f - x_i = v_{ix}t + \frac{1}{2}at^2$$

$$x_f = 28.2(2.315)$$

$$x_f = 65.283\,m \quad (b)$$

$$v_{fy} = v_{iy} + at$$

$$v_{fy} = -10.26 - 9.8(2.315)$$

$$v_{fy} = -32.947\,m/s$$

$$|v_f| = \sqrt{28.2^2 + (-32.947)^2}$$

$$v_f = 43.368\,m/s \quad (c)$$

Part C:

experimentals:

$t_1 = .700s$

$t_2 = 4.800s$

William Tell can shoot an arrow with a speed of 25 m/s. With what two possible angles should he aim his bow to hit an apple placed on top of Walter, his son's head. His son is standing on a raised platform 15 m away. The apple is 6 m above the ground.

Theoretical: Calculate the angles and times of flight.

Experiment: Using the angles found in the theoretical part, set up in IP and find the times of flight and % error.

Part D:

experimentals:

$t = .525s$

$y_f = 7.167m$

William Tell aims his crossbow at an angle of 40° above the horizontal and shoots an arrow at a speed of 25 m/s at the same instant that Walter tosses a melon down from a 15 m tall platform, 10 m away.

a. How fast must the melon be thrown downward so that the arrow will hit it?

b. At what point above the ground did the arrow hit the melon?

c. What was the total time of flight?

Theoretical: Calculate the above.

Experiment: Using the initial velocity found in part a, set up in IP and find for parts b and c and % error.

Calculations:
(continued)

Part C:

x-comp

$x_i = 0m$

$x_f = 15m$

$v_i = 25\cos\theta = 21.87$

$v_f = 25\cos\theta = 21.87$

$a = 0 m/s^2$

$t = t_1$

y-comp

$y_i = 0m$

$y_f = 6m$

$v_i = 25\sin\theta = 12.12$

$v_f = v_f$

$a = -9.8 m/s^2$

$t = t_2$

$$x_f - x_i = v_i t + \frac{1}{2}at^2$$

$$15 = 25\cos\theta \, t$$

$$\boxed{\frac{15}{25\cos\theta} = t}$$

$$y_f - y_i = v_i t + \frac{1}{2}at^2$$

$$6 = 25\sin\theta\left[\frac{15}{25\cos\theta}\right] - 4.9\left[\frac{15}{25\cos\theta}\right]^2$$

$$6 = 15\tan\theta - 1.764\left[\frac{1}{\cos^2\theta}\right]$$

$$6 = 15\tan\theta - 1.7641(\tan^2\theta + 1)$$

$$6 = 15\tan\theta - 1.7641\tan^2\theta - 1.7641$$

$$1.7641\tan^2\theta - 15\tan\theta + 7.764 = 0$$

$$\tan\theta = .554 \ \& \ 7.95$$

$$\theta = 28.97°, 82.83°$$

theoreticals

$\theta_1 = 28.97°$

$\theta_2 = 82.83°$

$$t_1 = \frac{15}{25\cos(28.97)} = .6858 s$$

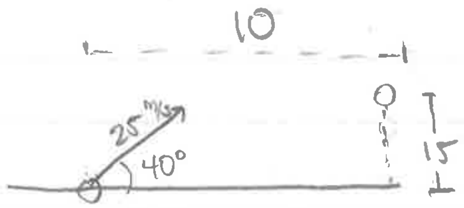
$$t_2 = \frac{15}{25\cos(82.83)} = 4.8072 s$$

Experimentals:

$t_1 = .700 s$

$t_2 = 4.800 s$

Part D:



x-comp

$x_i = 0\,m$

$x_f = 10\,m$

$a = 0\,m/s^2$

$v_{ix} =$ 19.15 m/s

$v_{fx} =$

$t = t$ ⟵ same ⟶ $t = t$

y-comp

$y_i = 0\,m$

$y_f = y_f$

$a = -9.8\,m/s^2$

$v_{iy} = 16.07\,m/s$

$v_{fy} = v_{fy}$

x

$x_f - x_i = v_i t + \frac{1}{2}at^2$

$10 = 19.15t$

$t = .522\,s$

c

$y_f - y_i = v_i t + \frac{1}{2}at^2$

$y_f = 16.07(.522) - 4.9(.522)^2$

$= 8.39 - 1.34$

$y_f = 7.054\,m$

b

y-comp of melon:

$y_i = 15\,m$

$y_f = 7.054\,m$

$a = -9.8\,m/s^2$

$v_i = v_i$

$v_f = v_f$

$t = .522$

$y_f - y_i = v_i t + \frac{1}{2}at^2$

$7.054 - 15 = .522v_i - 4.9(.522^2)$

$-7.946 = .522v_i - 1.335$

$-6.611 = .522v_i$

a

$v_i = -12.66\,m/s$

Calculations: (continued)

% error

Part A

① $\frac{4.4 - 4.41}{4.41} \times 100 = .23\%$ t

② $\frac{124.04 - 124.36}{124.36} \times 100 = .26\%$ X_f

③ $\frac{43.32 - 43.38}{43.38} \times 100 = .14\%$ V_f

Part B

① $\frac{2.32 - 2.315}{2.315} \times 100 = .22\%$ t

② $\frac{64.83 - 65.28}{65.28} \times 100 = .69\%$ X_f

③ $\frac{43.26 - 43.37}{43.37} \times 100 = .25\%$ V_f

Part C

① $\frac{.700 - .686}{.686} \times 100 = 2.0\%$ t_1

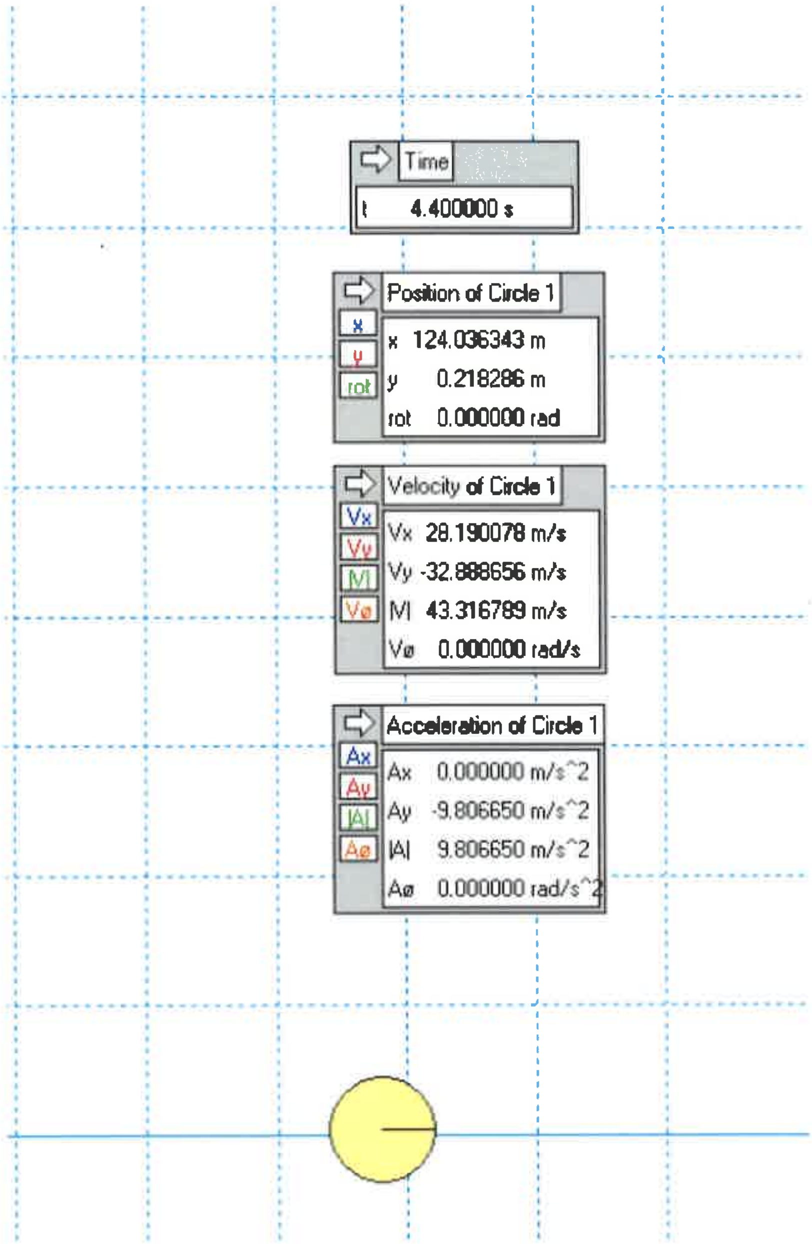
② $\frac{4.8 - 4.81}{4.81} \times 100 = .21\%$ t_2

Part D

① $\frac{7.17 - 7.05}{7.05} \times 100 = 1.7\%$ yf

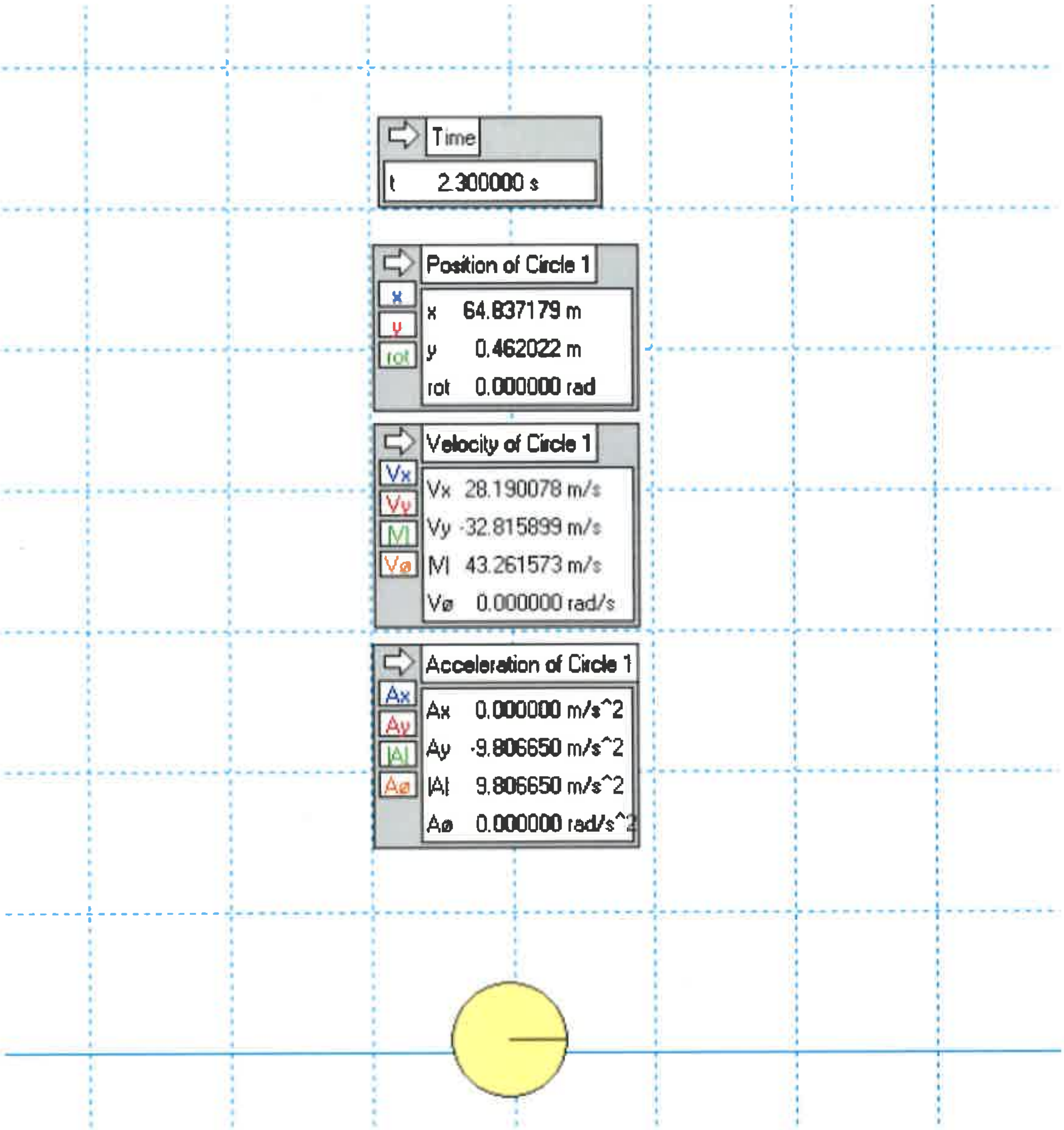
② $\frac{.525 - .522}{.522} \times 100 = .57\%$ t

Part A: a-c

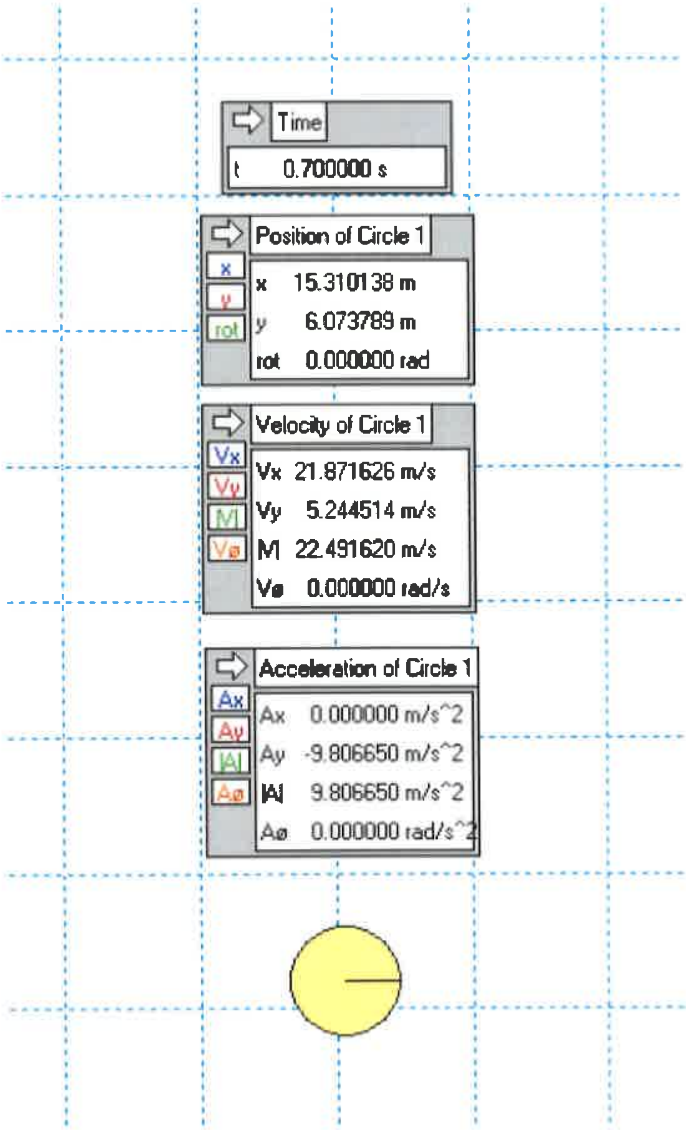


-4 include initial and final screenshots

Part B: a-c

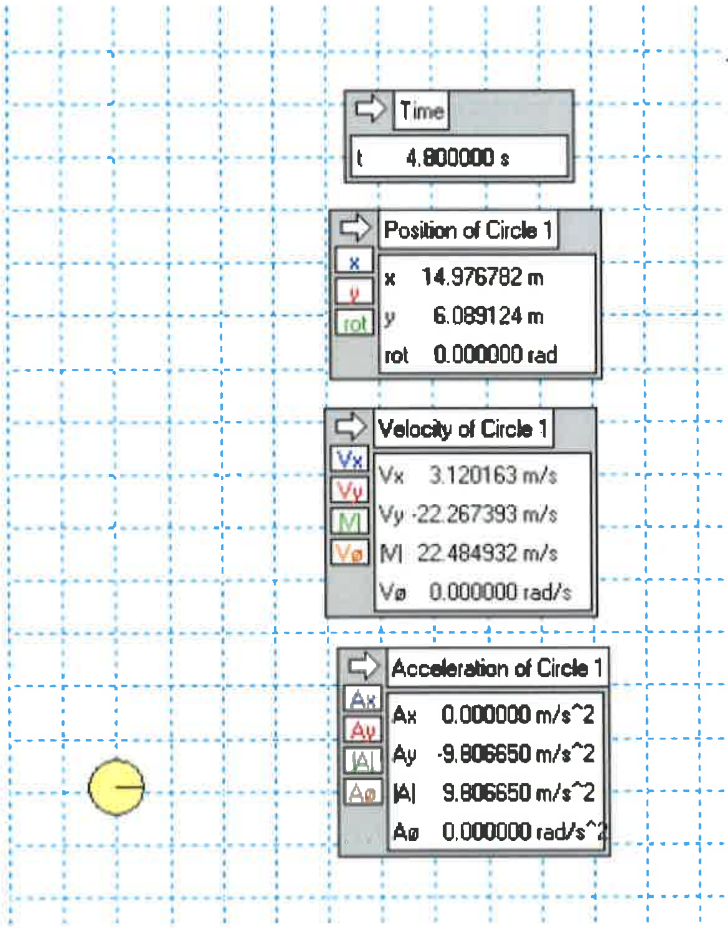

Time
t 2.300000 s
Position of Circle 1
x
y
rot
x 64.837179 m
y 0.462022 m
rot 0.000000 rad
Velocity of Circle 1
Vx
Vy
|V|
Vø
Vx 28.190078 m/s
Vy -32.815899 m/s
|V| 43.261573 m/s
Vø 0.000000 rad/s
Acceleration of Circle 1
Ax
Ay
|A|
Aø
Ax 0.000000 m/s^2
Ay -9.806650 m/s^2
|A| 9.806650 m/s^2
Aø 0.000000 rad/s^2

Part C : a

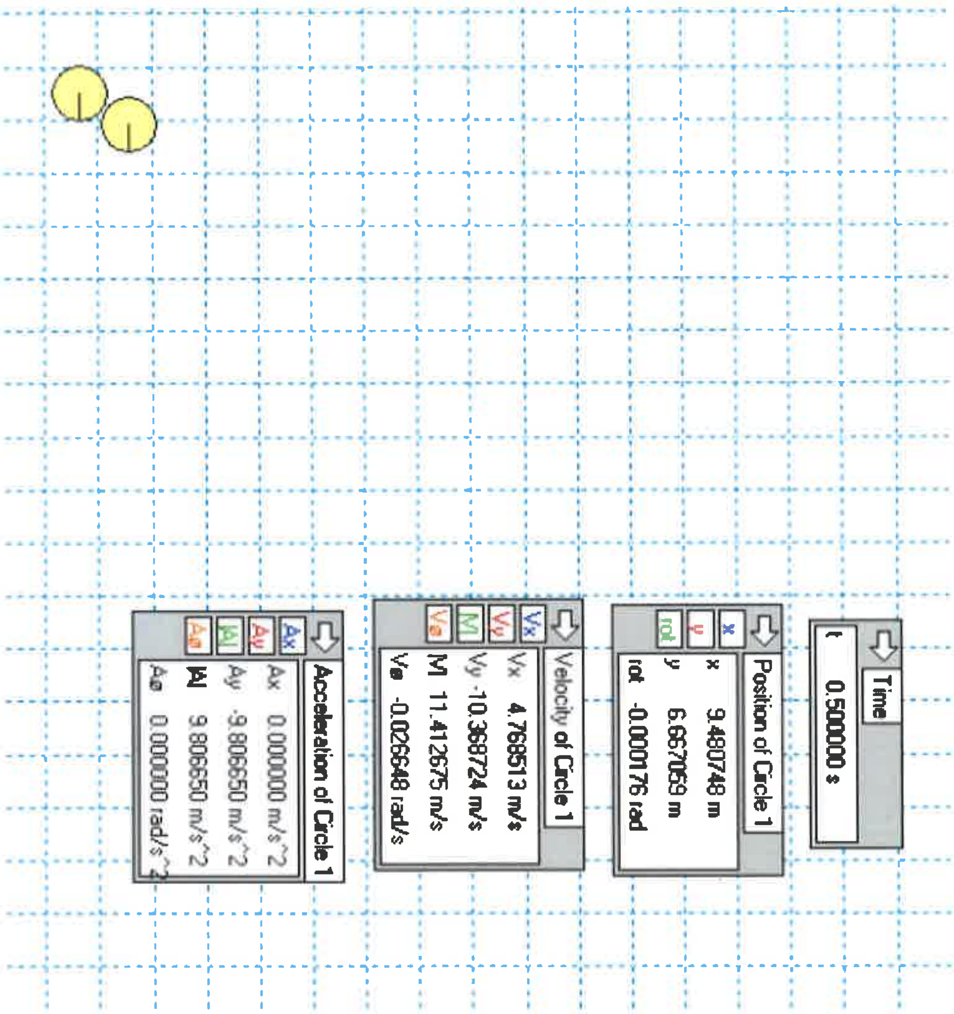


Time
t 0.700000 s
Position of Circle 1
x 15.310138 m
y 6.073789 m
rot 0.000000 rad
Velocity of Circle 1
Vx 21.871626 m/s
Vy 5.244514 m/s
|V| 22.491620 m/s
Vø 0.000000 rad/s
Acceleration of Circle 1
Ax 0.000000 m/s^2
Ay -9.806650 m/s^2
|A| 9.806650 m/s^2
Aø 0.000000 rad/s^2

Part C: b


Time
t 4.800000 s
Position of Circle 1
x 14.976782 m
y 6.089124 m
rot 0.000000 rad
Velocity of Circle 1
Vx 3.120163 m/s
Vy -22.267393 m/s
|V| 22.484932 m/s
Vø 0.000000 rad/s
Acceleration of Circle 1
Ax 0.000000 m/s^2
Ay -9.806650 m/s^2
|A| 9.806650 m/s^2
Aø 0.000000 rad/s^2

Part D :



Acceleration of Circle 1
Ax 0.000000 m/s^2
Ay -9.806650 m/s^2
|A| 9.806650 m/s^2
Aø 0.000000 rad/s^2
Velocity of Circle 1
Vx 4.768513 m/s
Vy -10.368724 m/s
|V| 11.412675 m/s
Vø -0.026648 rad/s
Position of Circle 1
x 9.480748 m
y 6.667059 m
rot -0.000176 rad
Time
t 0.500000 s