Simulated Kinematic Lab II

In this lab we will be using Beyond Labz to conduct a simulated experiment in which we will analyze the motion of a ball rolling down an incline plane. Position, velocity and acceleration graphs each can represent acceleration in different ways and understanding what they show is important to understanding motion of all types. Physicists use these different types of motion graphs together to show different perspectives of the motion being studied. Motion graphs are typically made of the position, velocity and acceleration data over time. They do not actually show the x-y position in space, but show how the object is changing position based on an initial reference point. So, the position graph is just representing the distance from a reference point over time and cannot be used to deduce two-dimensional motion changes. In this activity, the motion is limited to the surface of a ramp, so the object is confined to a single line of motion. The distance of the ball from the bottom of the ramp is just the length along the ramp surface, or the hypotenuse of the triangle, not the x and y positions of the object.

Procedure

1. Start Virtual Physics and select Graphing Accelerated Motion from the list of assignments. The lab will open in the Mechanics laboratory.

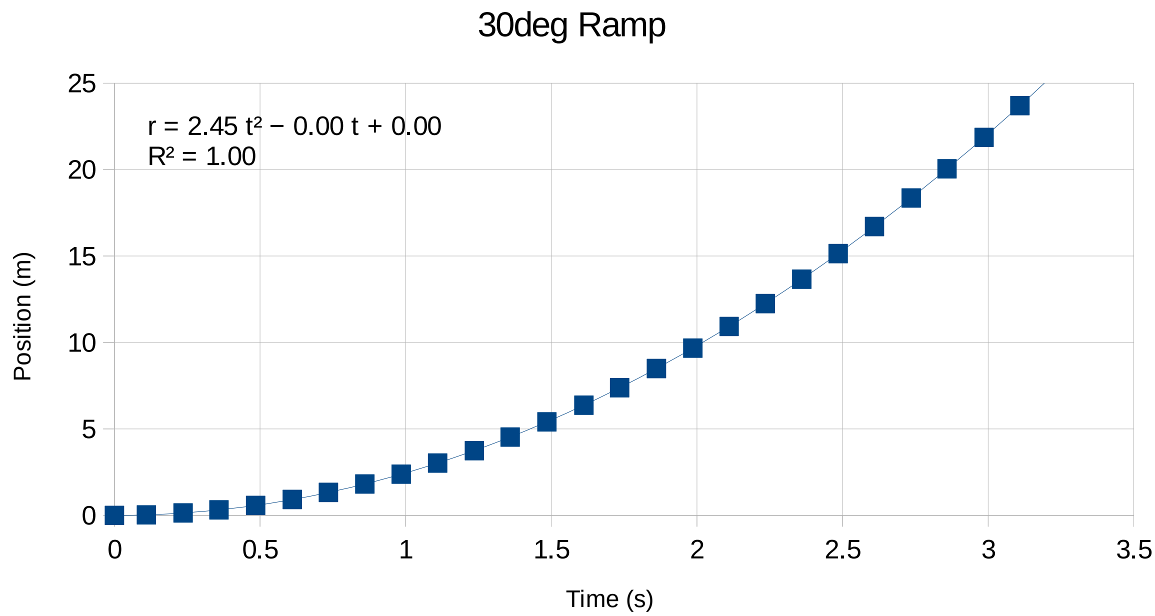
2. The laboratory will be set up with a ball on a ramp. The ramp has an angle of 30 degrees. Click the red Recording button to start recording data. Start the ball rolling down the ramp by clicking the Start button. Observe what happens as the ball hits the end of the ramp. You will see a link appear in the Lab Book that contains the position, velocity and acceleration versus time data for the ball rolling down the ramp.

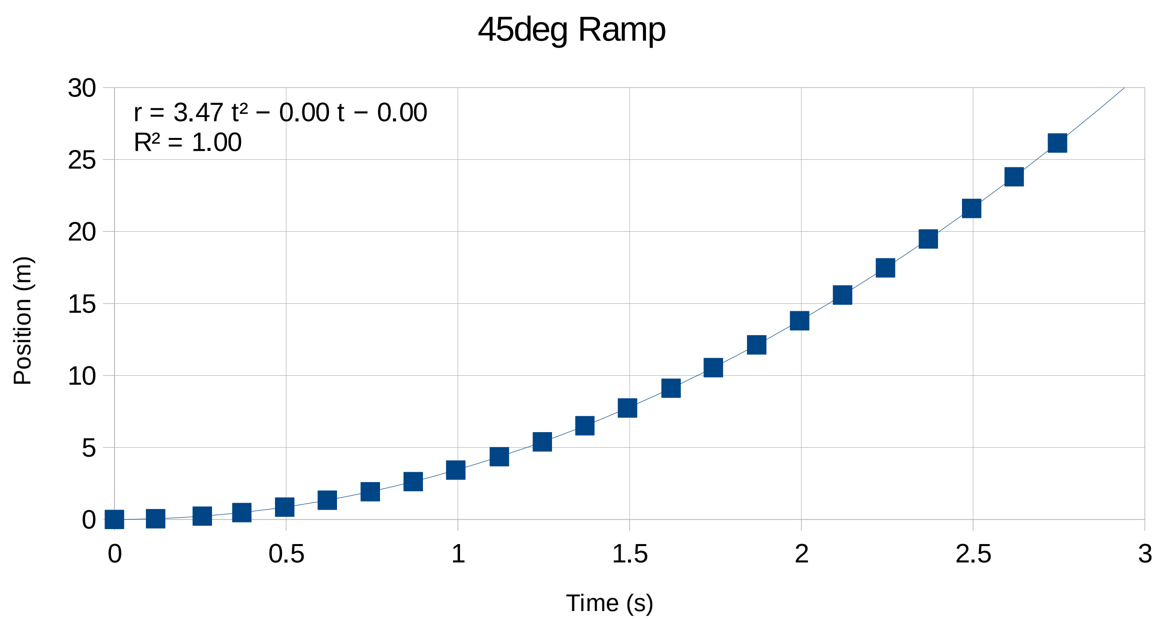
3. Click the Reset button to move the ball back to the top of the ramp. Set the angle of the ramp to 45 degrees using the Parameters Palette. Repeat Step 2. Repeat the experiment once more with the ramp at 60 degrees. You should now have three data links in your lab book. Double click beside each link to label the link with the angle of the ramp.

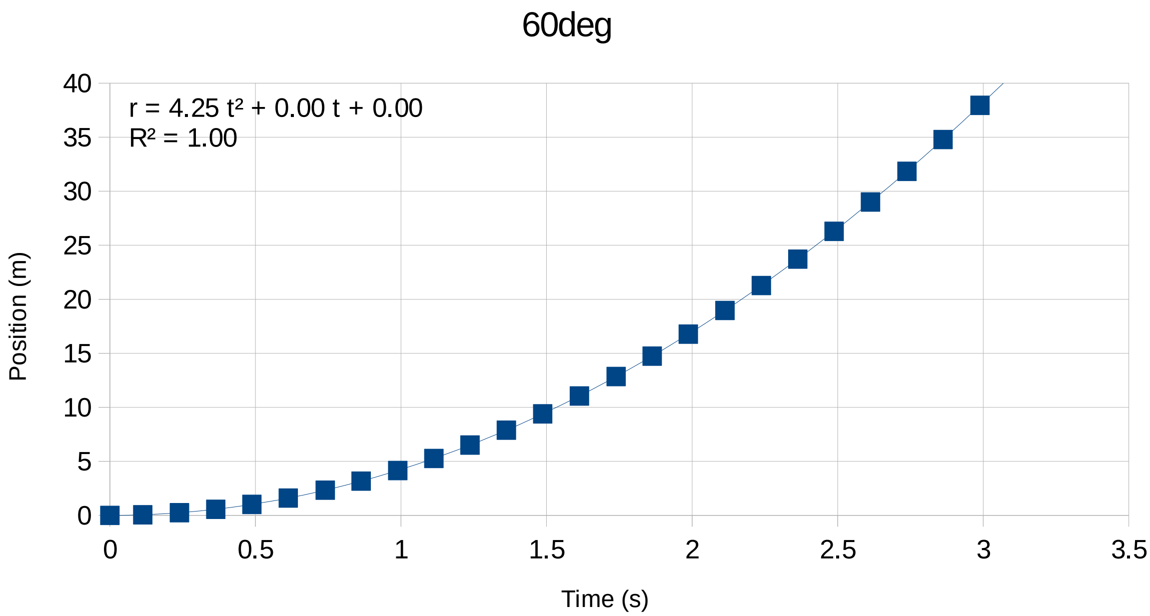
4. Once you are satisfied with the data that you collected, copy the data from your lab book and paste it into an Excel work sheet.

Data Analysis

1. Plot the position vs time graph for each of the incline angles. Make sure each of the graphs have the appropriate titles and units.

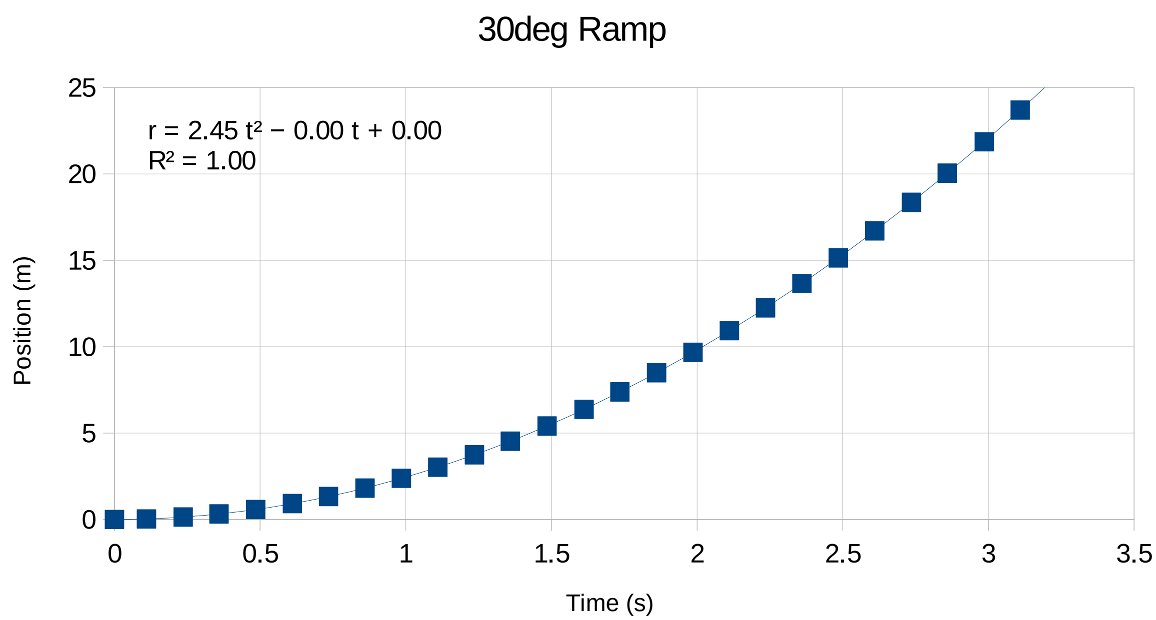

30deg Ramp
r = 2.45 t² − 0.00 t + 0.00
R² = 1.00
Position (m)
Time (s)
0
5
10
15
20
25
0
0.5
1
1.5
2
2.5
3
3.5


45deg Ramp
r = 3.47 t² − 0.00 t − 0.00
R² = 1.00
Position (m)
Time (s)
0
5
10
15
20
25
30
0
0.5
1
1.5
2
2.5
3



2. Fit each of the position vs time graphs to a second-degree polynomial function. In lecture you learned that an object undergoing constant acceleration in one dimension must obey the equation $x_f = \frac{1}{2} a t^2 + v_o t + x_o$.

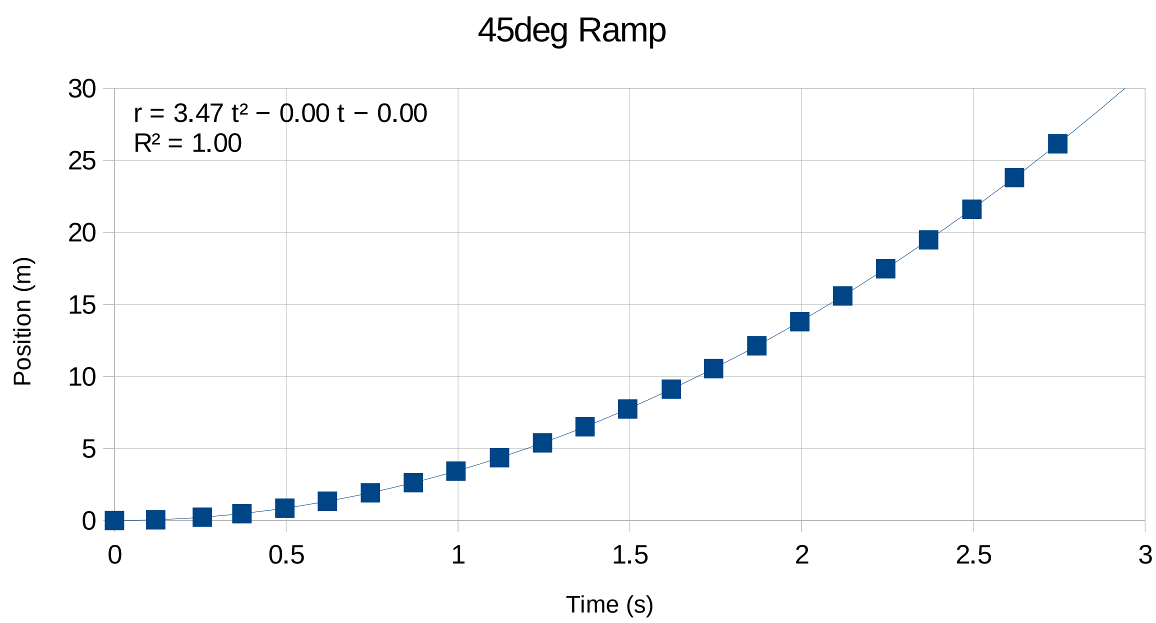
   Determine the acceleration at all three angles of inclination and paste each of the graphs with the trendlines, equations of the line of best fit, and the R-squared value in the space below.



1/

2 * a = 2.45m/s^2

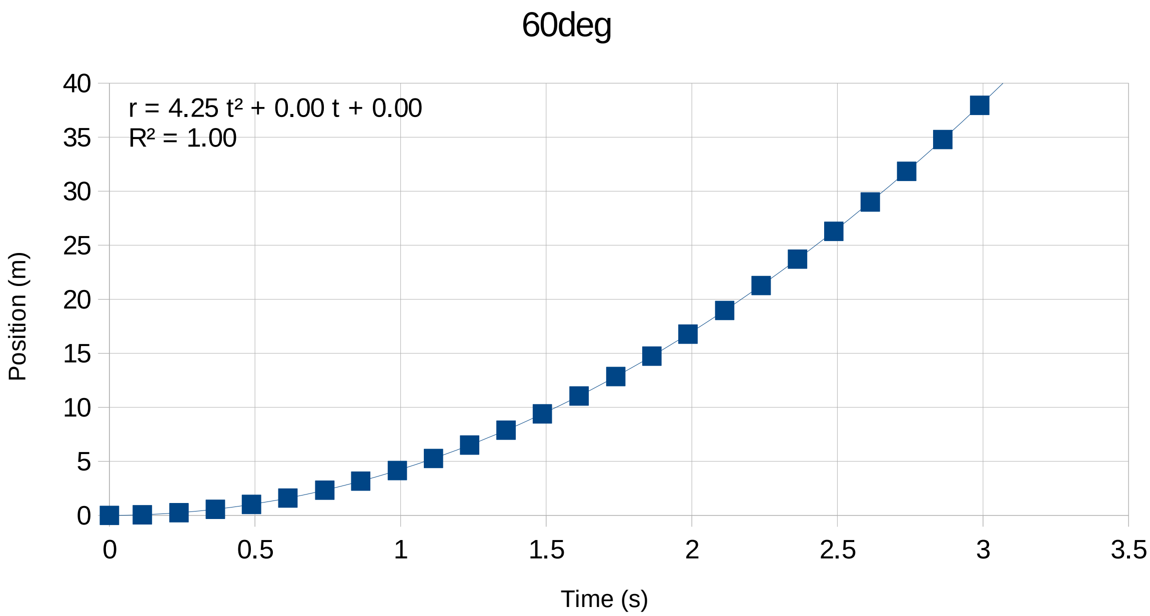
a = 4.90m/s^2



1/

2 * a = 3.47m/s^2

a = 6.93m/s^2



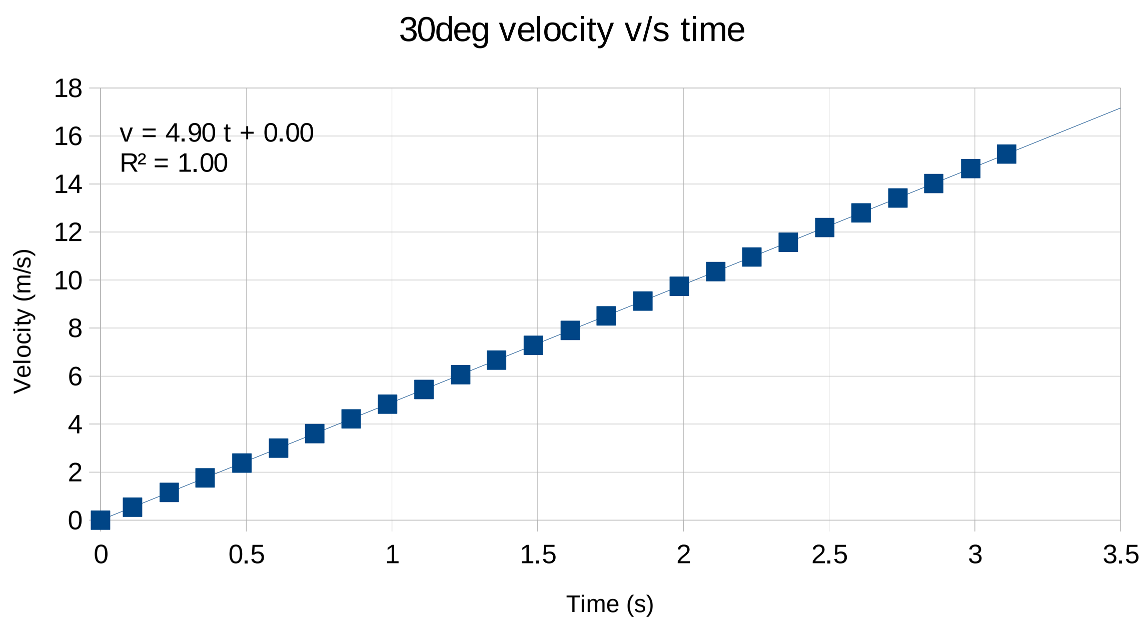
1/2 * a = 4.25m/s^2

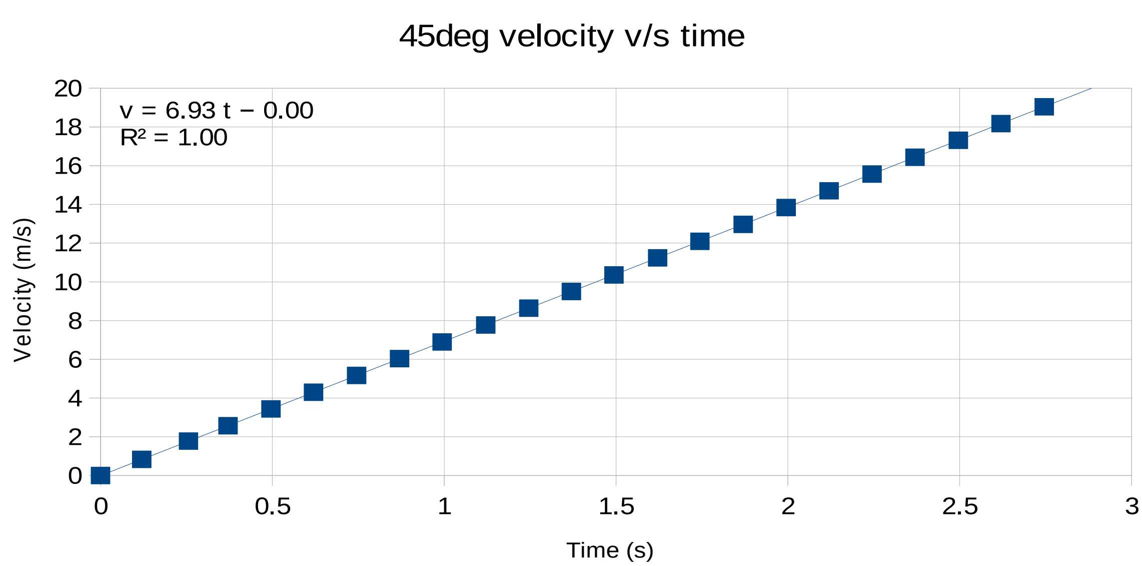
a = 8.50m/s^2

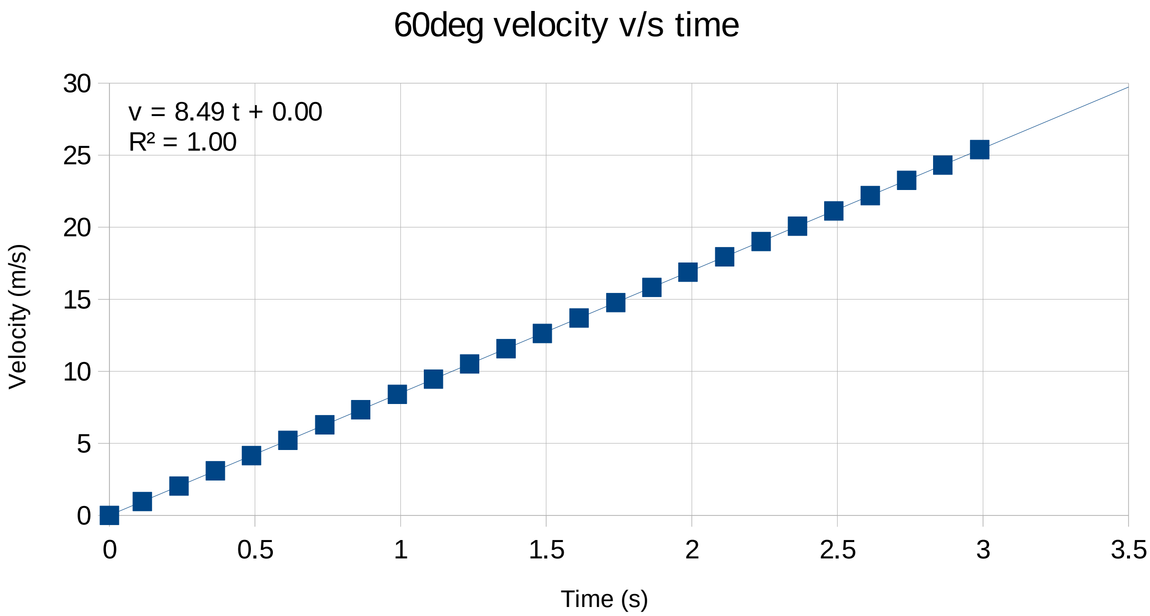
3. Given that the acceleration down an incline plane is $gsin\theta$ where θ is the angle of inclination, compare the value obtained from the fit to $gsin\theta$ for each of the angles of inclination.

Angle	Experimental Acceleration (m/s^2)	Expected Acceleration gsinθ (m/s^2)
30	4.90	4.9
45	6.93	6.93
60	8.50	8.49

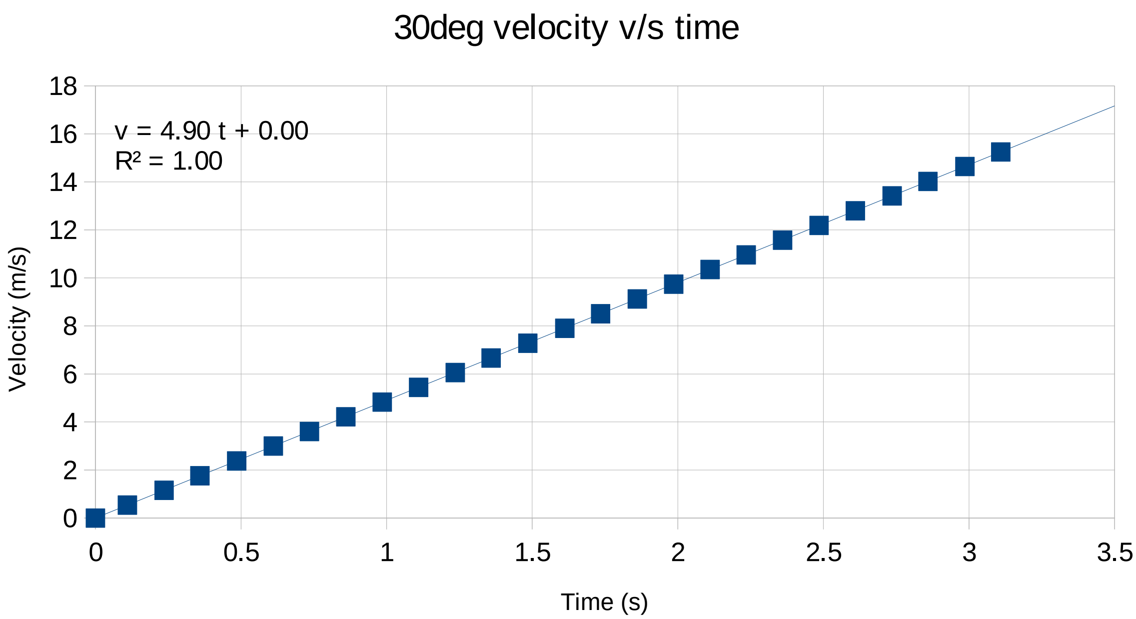
4. Now plot the velocity vs. time graph for each of the angles of inclination and paste them in the space below. Make sure each of the graphs have the appropriate titles and units.



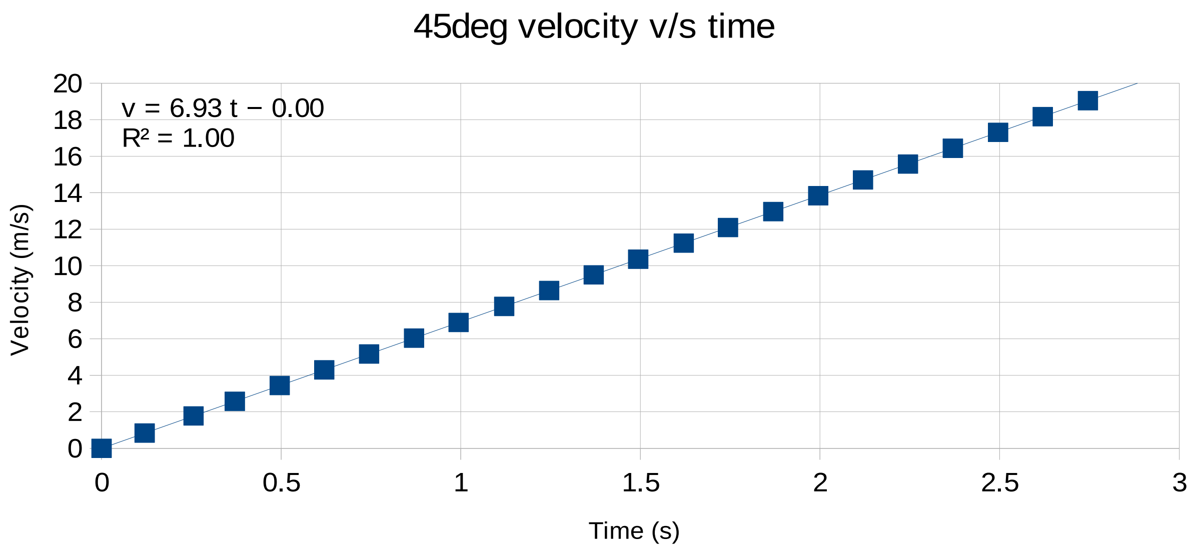




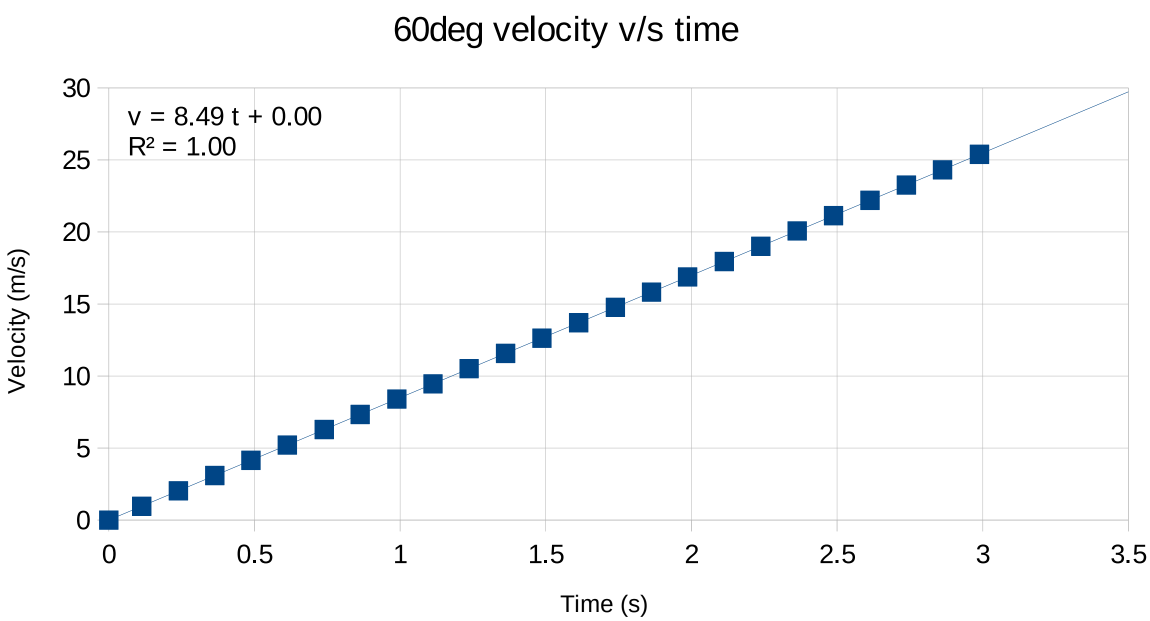
5. Fit each of the velocity vs time graphs to a linear function. In lecture you learned that an object undergoing constant acceleration in one dimension must obey the equation $v=at+v_o$. Determine the acceleration at all three angles of inclination and paste each of the graphs with the trendlines, equations of the line of best fit, and the R-squared value in the space below.



a = 4.9m/s^2



a = 6.93m/s^2



a = 8.49m/s^2

6. Compare the acceleration obtained from the fit from question 2, from question 5, and from calculating $gsin\theta$.

Angle	Question 2 Acceleration (m/s^2)	question 5 Acceleration (m/s^2)	Expected Acceleration gsinθ (m/s^2)
30	4.90	4.90	4.9
45	6.93	6.93	6.93
60	8.50	8.49	8.49