Video Analysis of Accelerated Motion

Analysis Questions:

1. Position vs. Time analysis
    a. Fit Parameters: A _____ B _____ C _____ (numerical values)
    b. Equation for position vs. time using fit parameters:

    c. Equation for A in terms of the motion: A = _____
    d. a = _____
    e. x_i = _____
    f. x_f = _____
    g. Δx = _____
2. Velocity vs. Time analysis
    a. Slope = _____ and is the _____ of the motion.
    b. % difference calculation:

    c. Equation for velocity vs. time:
    d. Integral value = _____ which is the _____ of the motion.
    e. % difference calculation:

3. Position and time have a _____ relationship during constant acceleration.
4. Velocity and time have a _____ relationship during constant acceleration.

% difference = (difference between two values / average of the two values) x 100

Video Analysis of Accelerated Motion

Open Logger Pro and then insert the acceleration 2 video by opening the *Insert* menu and selecting *Movie*. Follow your instructor's directions for the location of the video clip. This video shows a dynamics cart accelerating down a track with a meter stick in the foreground.

Once the movie appears on the screen, note the five buttons on the lower left side of the Movie Player. The left-most is the *Play* button. The next button to the right is the *Stop* button. It will stop the movie during replay. The third button from the left rewinds the video to the beginning. The next two buttons move the video to the previous or next frames. The slider bar lets you scroll through the video. Click the *Play* button to watch the cart roll across the screen.

The far right button in the movie player will open or close the video analysis tools, which appear on the right side of the movie player. A graph will also be displayed. If necessary, resize or move the graph to the right of the movie. To make the analysis easier to see, click on the video window to highlight it. Then enlarge it by dragging the handle in a corner of the video window with the mouse until it occupies most of the screen. Do not use the handles on the side or bottom of the video window or you will distort the perspective and throw your results off.

Now set a scale for the analysis. When the video was made, a meter stick was placed in front of the track. Click the *Set Scale* button, which is the fourth button from the top of the movie player on the right side. Now click and drag the mouse from one end of the stick to the other end. A pop-up dialog box will appear. Accept the default of "1" for the Distance and click OK.

Click the *Play* button, and when the cart begins to move, click the *Stop* button. Click the *Next Frame* button or *Previous Frame* button to locate the beginning of the cart's motion. Now click the *Add Point* button (second from the top). Move your mouse over the movie and use the cross hairs to identify the front of the cart or the white dot on the cart. Click the mouse once. Notice that a mark is left on the screen and the movie advances one frame. Mark the front of the cart again and repeat this process until you have located 30 points. Now click the movie *Rewind* and *Play* button to see the cart move down the track, and watch the trail of its position.

Now for the analysis, bring the graph to the front by clicking on it to make it active. You may need to resize the video to access the graph.

1. Position vs. Time analysis: The graph will initially show both vertical and horizontal position. Click the *y*-axis label and choose "X". The graph now shows horizontal position vs. time. Use the curve fit button to fit a quadratic to the graph.
    a. Record the three fit parameters, **A**, **B**, and **C**
    b. Write the complete equation for the position as a function of time using the fit parameters.
    c. According to our work in class, the magnitude of **A** (the coefficient of the t^2 term) should be equal to what value?
    d. Calculate the acceleration from the fit parameter and record its value.
    e. Click the examine button and move the cursor to the first point on the graph. Record the position as the initial position of the motion.
    f. Move the cursor to the last point and record the final position.
    g. Calculate the total displacement for the motion and record its value.
2. Velocity vs. Time analysis: Click the *y*-axis label and choose "X velocity ". Fit a line to the graph using the linear fit button.
    a. Record the slope. What physical quantity does this slope give you?
    b. Check how well your value of this quantity agrees with the value recorded earlier in your analysis of the position graph. Find the % difference.
    c. Write the equation for the x-velocity as a function of time using the fit parameters found by the computer.
    d. Now find the area under the velocity vs. time graph by clicking the integral button. The area will now be filled by a color (red by default). Record the value from the computer. What physical quantity does this area give you?
    e. Check to see how well the value shown by the integral agrees with your earlier measurement of this quantity. Find the percent difference.
3. Using your results, what do you conclude about the type of relationship between position and time during acceleration?
4. What do you conclude about the type of relationship between velocity and time during acceleration?