Worksheet 6: 2D Kinematics

Name: _____

Due March 26, 2026

Partner: _____

<u>Pencil only: use of Pen is forbidden.</u>

As usual, turn your Excel document into the Google form, with both plots. The plots should use the template, AND have proper axis labels, rational sig-figs on the axes, labels, a good trendline, etc.
Remember that answers to the discussion questions are to be based on numbers, not guesses or feelings.

- Record $\theta_{\text{0-direct}}$ found using the protractor/plumb-bob. Estimate an uncertainty!

- Recall that Tracker may mess up the time column. Use the first time from Tracker to compute Δt and the frame rate. You expect $\Delta t \approx 0.033$ s and frame rate ≈ 30 fps.

- Make a column of integers for "frame number", starting at 0.

- Make a column called t_{cam} using frame number $\times \Delta t$. Use a dollar sign for the formula's reference to Δt.

- Leave a blank column, then make copies of your x and y columns.

- Find a linear fit ($x = c_1 t_{\text{cam}} + c_2$) for your x vs t_{cam} data.

- Compute $t_{\text{offset}} = c_2/c_1$. We expect that $t_{\text{offset}} < \Delta t$.

- In the blank column, create new times: $t_{\text{true}} = t_{\text{cam}} + t_{\text{offset}}$. Use a dollar sign for the formula's reference to t_{offset}.

- Find a new linear fit ($x = c_3 t_{\text{true}} + c_4$) for your x vs t_{true} graph.

- Find a parabolic fit ($y = c_5 t^2_{\text{true}} + c_6 t_{\text{true}} + c_7$) for your y vs t_{true} graph.

- Using your various c values, determine v_{0x}, v_{0y}, v_0, and a_y.

- Use your values for v_{0x} and v_{0y} to determine θ_0.

Quantity	**Result**
Δt_{video} (s)	
Frame rate (fps)	
$\theta_{\text{0-direct}}$ (°)	±
c_1 (cm/s)	±
c_2 (cm)	±
t_{offset} (s)	
c_3 (cm/s)	±
c_4 (cm)	±
c_5 (cm/s^2)	±
c_6 (cm/s)	±
c_7 (cm)	±
$v_x = v_{0x}$ (cm/s)	±
v_{0y} (cm/s)	±
v_0 (cm/s)	
a_y (cm/s^2)	±
$\theta_{\text{0-calc}}$ (°)	±

On the quiz, we didn't even bother to find c_3 or c_4. Based only on your values for c_1, c_2, c_3, and c_4, explain why we skipped that step.

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You expected that $a_y = -g$. Discuss the level of agreement of your result with this expectation.

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Discuss the level of agreement of your two values for θ_0.

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