EXPERIMENT: Phil Harmonic wanted to determine the relationship between time and distance as he rode his bike. He hypothesized that the relationship was linear. As he biked, his friend measured the total distance Phil had traveled after each second.

Time (s) ± 0. 2 s	Distance (m) ± 2 m (y axis)
1.0	12
2.2	25
3.1	32
4.2	45

1. Graph the data on graph paper. Be sure to include all labels and error bars as well as a best-fit line. Attach the graph paper to this worksheet.

2. Calculate the slope of the best-fit line. Show your work below, including the equation and substitution with units.

points = (4.2s, 45m), (2.95s, 32m)

slope = $m = \frac{\Delta y}{\Delta x} = \frac{(45m - 32m)}{(4.2s - 2.95s)}$

= 10.4 m/s

3. Write the experimental relationship for your data.

Experimental Relationship:

y = mx + b → slope = 10.4 m/s, y-intercept = 1.7 m → D = (10.4 m/s)T + 1.7m

4. Use the mathematical model **distance = velocity x time** (d = v ·t) to make a conclusion about the meaning of the slope by comparing the math model to your experimental relationship. State your conclusion here.

By comparing the experimental equation to the mathematical model, the slope represents the velocity of the cyclist so the velocity of Phil riding his bike is 10.4 m/s.

5. Draw a line of maximum slope and a line of minimum slope through your errors bars on the graph. Then, state the slopes of the max and min lines. (You do not need to show these calculations.)

slope of max line = 11.5 m/s , slope of min line = 9.2 m/s

6. State the value for the best-fit slope with its uncertainty. Show how you obtained the uncertainty.

Maximum slope = 11.5 m/s

minimum slope = 9.2 m/s

Best-fit slope = 10.4 m/s

Range = (11.5 m/s − 9.2 m/s) = 2.3 m/s

Uncertainty = $\frac{1}{2}$(Range) = $\frac{1}{2}$(2.3 m/s) = 1.15 m/s → round to 1 m/s

Best-fit slope with its uncertainty = 10. m/s ± 1 m/s

To the right is a sample data set for an experiment involving distance and time for a falling object.

Time (s) ± 0.05 s	Distance Fallen (m) ± 0.005 m	Time Squared (s^2)
0.00	0.000	0.00
0.10	0.049	0.01
0.20	0.196	0.04
0.30	0.451	0.09
0.40	0.774	0.16
0.50	1.320	0.25
0.60	1.700	0.36
0.70	2.500	0.49
0.80	3.140	0.64
0.90	4.000	0.81
1.00	4.900	1.00

1. Graph the data on graph paper. Be sure to include all labels and error bars as well a best-fit curve drawn smoothly by hand. Attach the graph paper to this worksheet.

2. Name the type of relationship you have plotted.

   Quadratic

3. State the general equation of the best-fit shape.

   $Y = Cx^2$

4. Fill in the third data column with an appropriate heading (with units) and transformed data that will be used to straighten the graph. No uncertainties are needed on the transformed data.

5. Graph the straightened data on graph paper on a new set of axes using proper graphing techniques. No error bars are needed on the straightened graph. Attach that graph to this worksheet as well.

6. Calculate the slope of the straightened graph. Show your work below, including the equation and substitution with units. points = $(0.1\,s^2, 0.5\,m)$, $(0.2\,s^2, 1.0\,m)$

   $\text{Slope} = m = \frac{\Delta Y}{\Delta X} = \frac{(1.0\,m - 0.5\,m)}{(0.2\,s^2 - 0.1\,s^2)} = \boxed{5\ m/s^2}$

7. Use the general equation of your original graph and the slope of your straightened graph to write the experimental relationship for your data.

   General equation → $y = Cx^2$, Slope of straightened graph = $5\ m/s^2$, y-intercept = 0 m

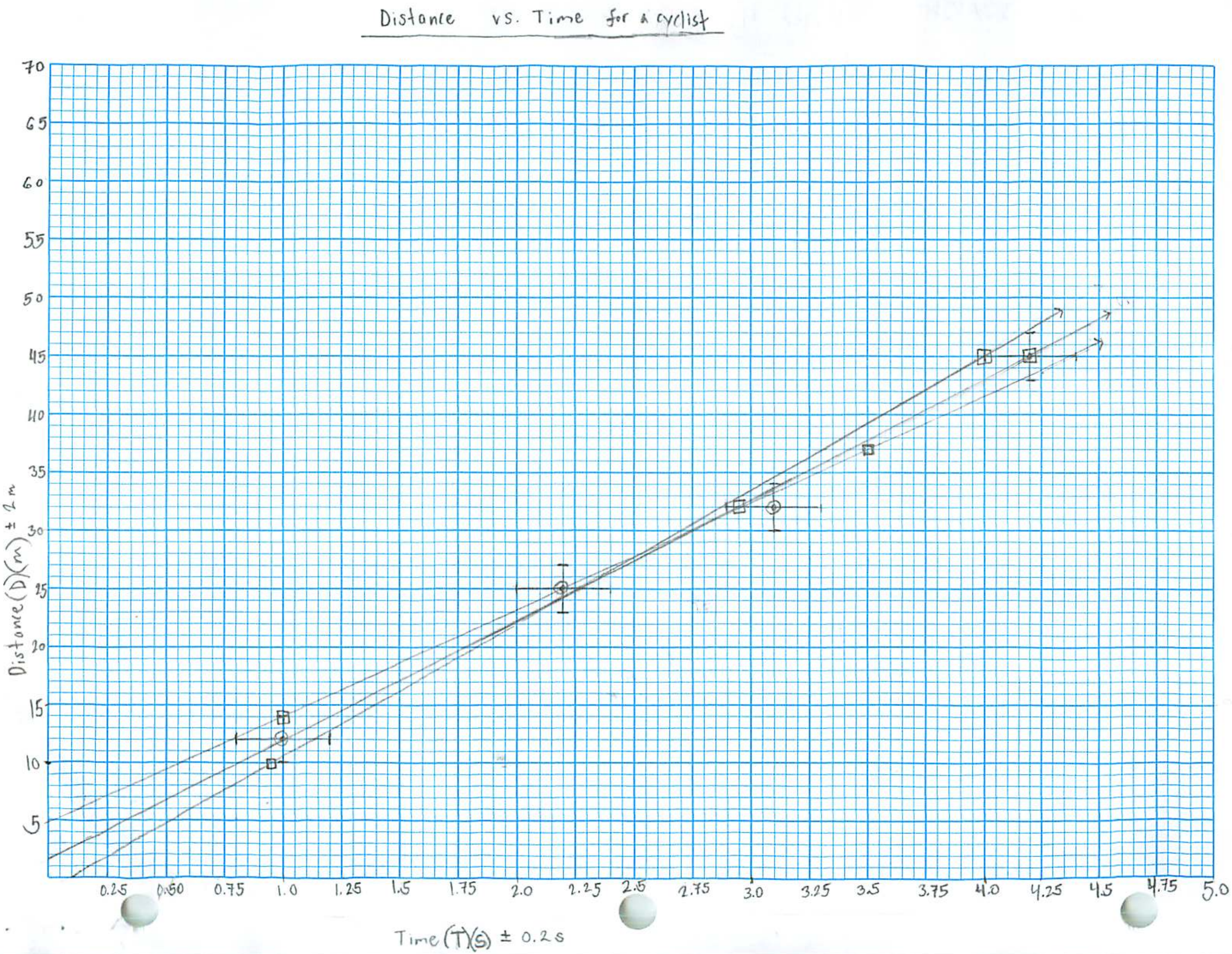
   Experimental Relationship = $D = (5\ m/s^2)T^2 + 0\,m$, $\boxed{D = (5\ m/s^2)T^2}$

8. Use the mathematical model **distance = ½ acceleration x time²** ($d = ½\,a \cdot t^2$) to make a conclusion about the meaning of the slope by comparing the math model to your experimental equation. State your conclusion here.

   By comparing the mathematical model to the experimental equation, the slope represents one half of the acceleration of the object, so the acceleration of the falling object is 10 m/s².

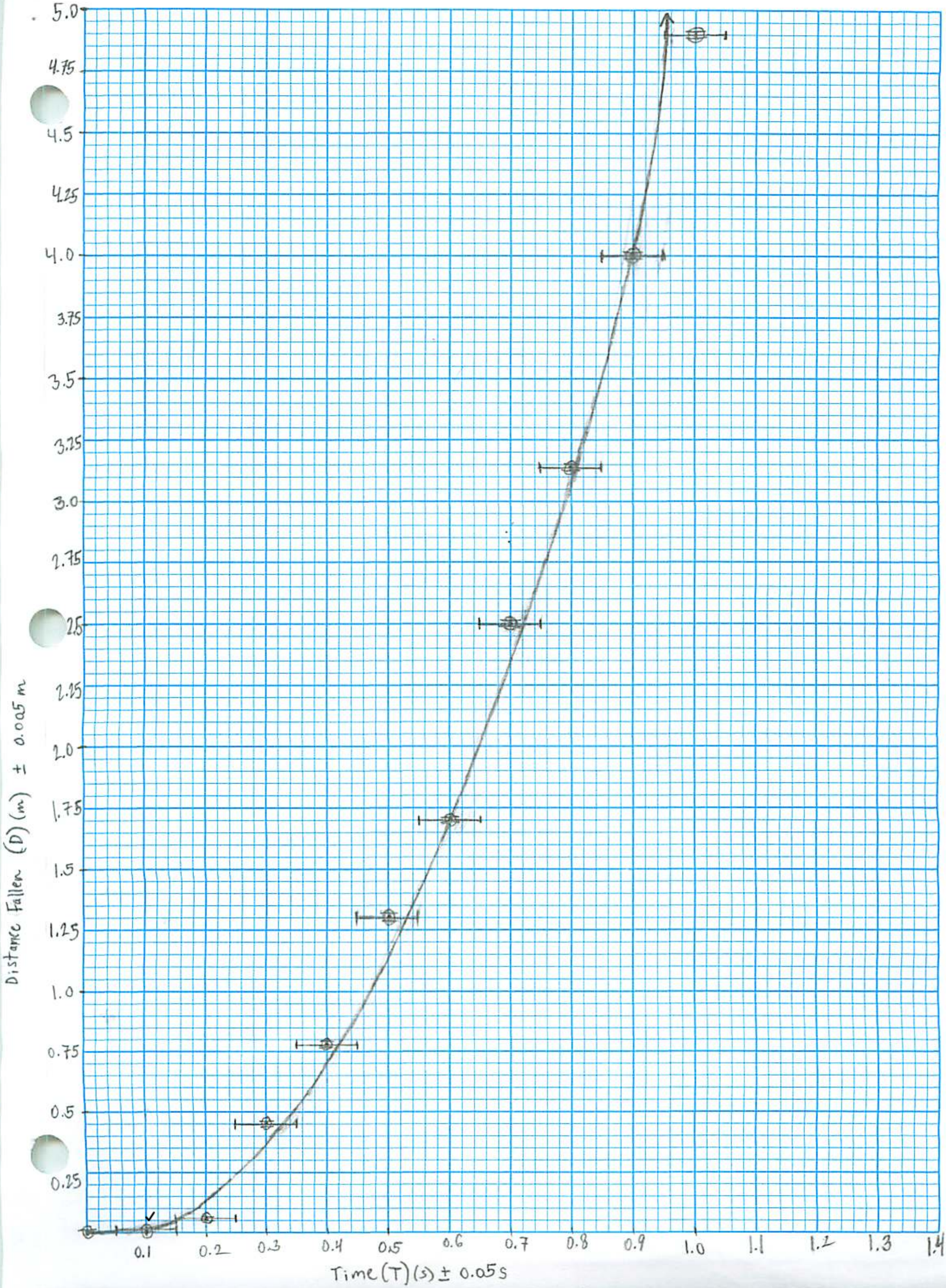
9. State the acceleration of the object.

   The acceleration of the object is 10 m/s².



Distance vs. Time for a cyclist
Distance (D)(m) ± 2 m
Time (T)(S) ± 0.2 s
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0.25
0.50
0.75
1.0
1.25
1.5
1.75
2.0
2.25
2.5
2.75
3.0
3.25
3.5
3.75
4.0
4.25
4.5
4.75
5.0

Distance Fallen vs. Time for a falling object



Distance Fallen vs. Time Squared for a falling object