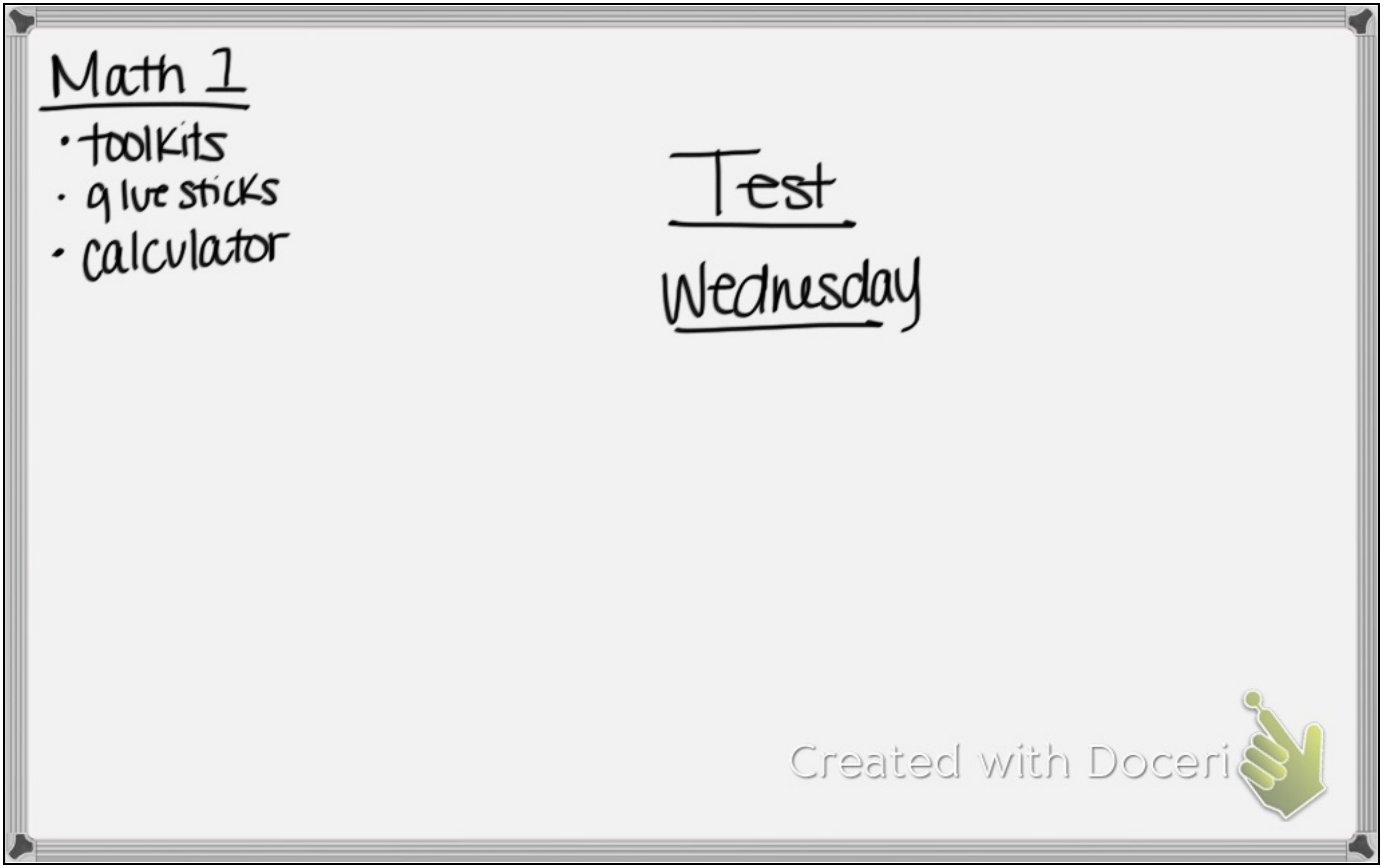
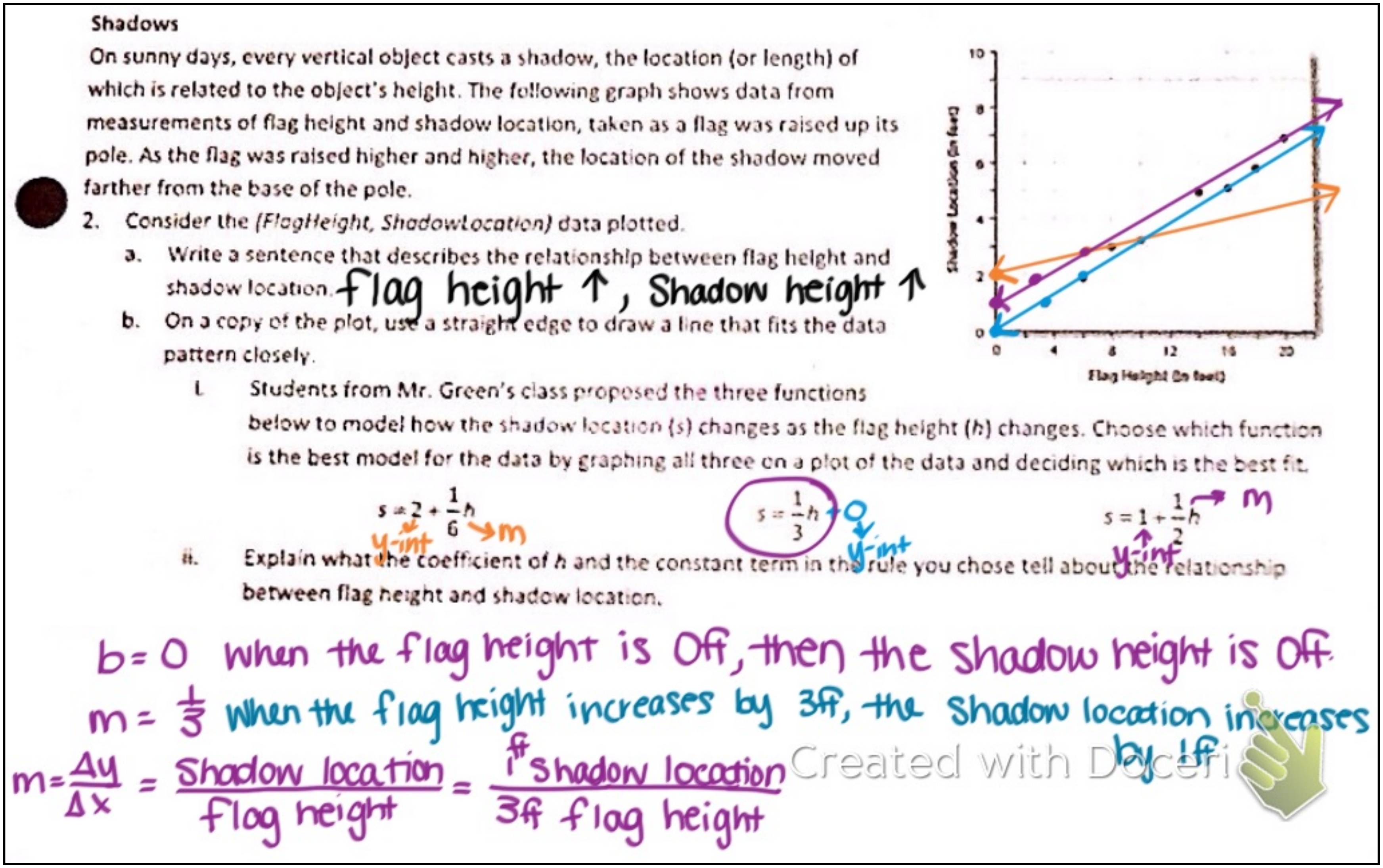


Math 1

- toolkits
- glue sticks
- calculator

Test

Wednesday



Shadows

On sunny days, every vertical object casts a shadow, the location (or length) of which is related to the object's height. The following graph shows data from measurements of flag height and shadow location, taken as a flag was raised up its pole. As the flag was raised higher and higher, the location of the shadow moved farther from the base of the pole.

2. Consider the *(FlagHeight, ShadowLocation)* data plotted.

   a. Write a sentence that describes the relationship between flag height and shadow location. flag height ↑, Shadow height ↑

   b. On a copy of the plot, use a straight edge to draw a line that fits the data pattern closely.

      i. Students from Mr. Green's class proposed the three functions below to model how the shadow location (*s*) changes as the flag height (*h*) changes. Choose which function is the best model for the data by graphing all three on a plot of the data and deciding which is the best fit.

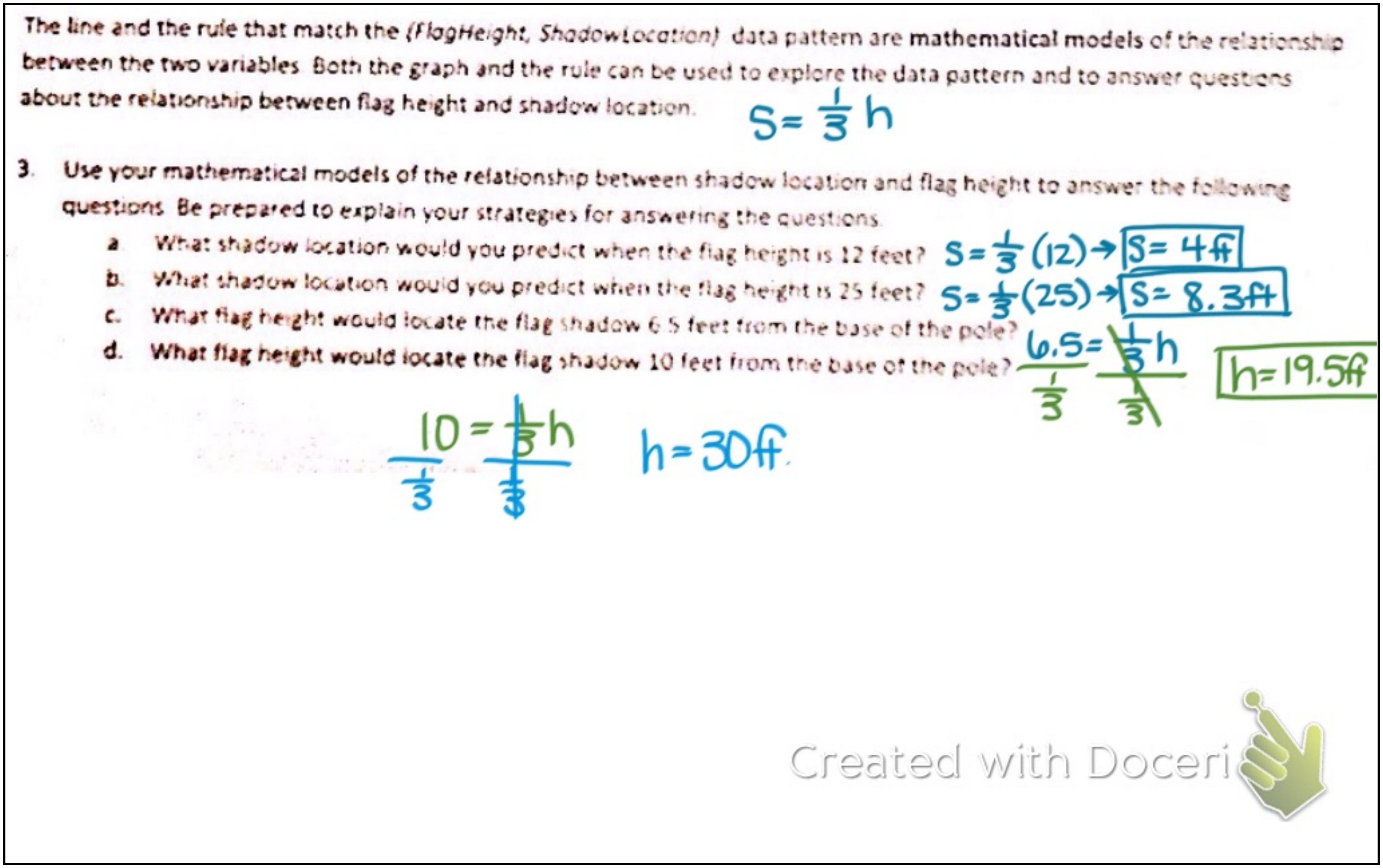
$$s = \underset{\text{y-int}}{2} + \frac{1}{6}h \rightarrow m \qquad \boxed{s = \frac{1}{3}h} + \underset{\text{y-int}}{0} \qquad s = \underset{\text{y-int}}{1} + \frac{1}{2}h \rightarrow m$$

      ii. Explain what the coefficient of *h* and the constant term in the rule you chose tell about the relationship between flag height and shadow location.

b= 0 when the flag height is 0ft, then the shadow height is 0ft.

$m = \frac{1}{3}$ when the flag height increases by 3ft, the shadow location increases by 1ft

$$m = \frac{\Delta y}{\Delta x} = \frac{\text{Shadow location}}{\text{flag height}} = \frac{1\text{ft shadow location}}{3\text{ft flag height}}$$



The line and the rule that match the *(FlagHeight, ShadowLocation)* data pattern are **mathematical models** of the relationship between the two variables. Both the graph and the rule can be used to explore the data pattern and to answer questions about the relationship between flag height and shadow location.

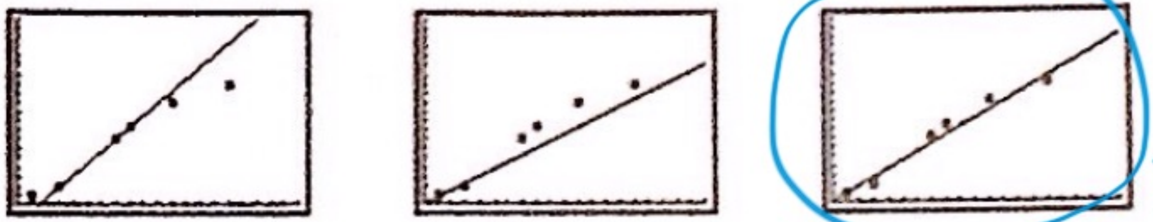
$S = \frac{1}{3}h$

3. Use your mathematical models of the relationship between shadow location and flag height to answer the following questions. Be prepared to explain your strategies for answering the questions.
   a. What shadow location would you predict when the flag height is 12 feet? $S = \frac{1}{3}(12) \rightarrow \boxed{S = 4ft}$
   b. What shadow location would you predict when the flag height is 25 feet? $S = \frac{1}{3}(25) \rightarrow \boxed{S = 8.3ft}$
   c. What flag height would locate the flag shadow 6.5 feet from the base of the pole? $\frac{6.5}{\frac{1}{3}} = \frac{\cancel{\frac{1}{3}}h}{\cancel{\frac{1}{3}}}$ $\boxed{h = 19.5ft}$
   d. What flag height would locate the flag shadow 10 feet from the base of the pole?

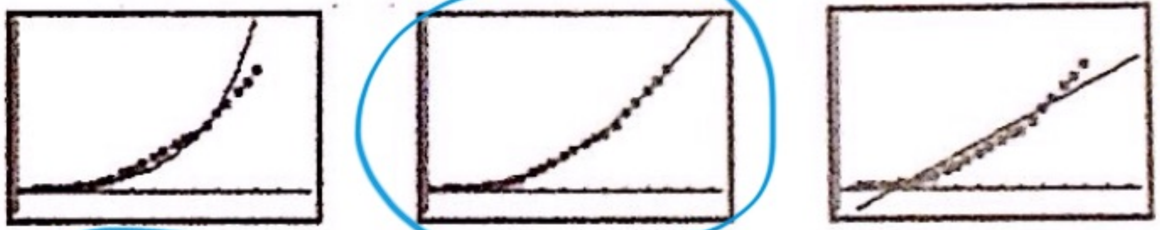
$\frac{10}{\frac{1}{3}} = \frac{\cancel{\frac{1}{3}}h}{\cancel{\frac{1}{3}}}$ $h = 30ft$

4. Which of the graphs below show the best model for the data and will create the best predictions? Circle your choice and explain why it is the best model.

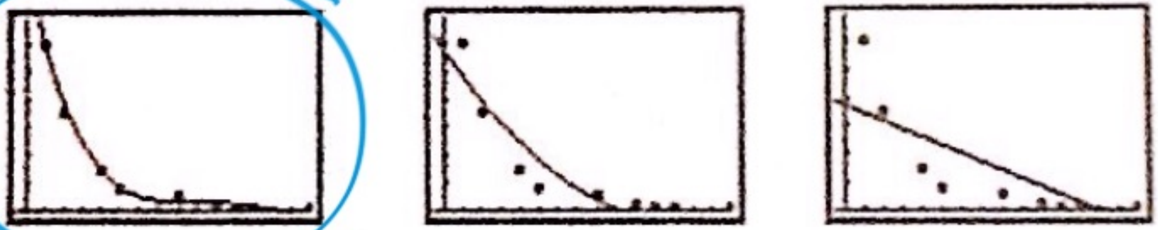
a.



b.



c.



* find the model that goes through the center of the data & extra points are equi-distant from the line

5. The men's 100-meter run has been in the Olympics since 1896. The winning time for each year since 1896 is shown in the table below.

L2

Winning Times for Men's Olympic 100 Meter Run

L1	Year	Time (sec)		Year	Time (sec)	Year	Time (sec)
0	1896	12.0	40	1936	10.3	1980	10.25
4	1900	10.8	52	1948	10.3	1984	9.99
8	1904	11.0		1952	10.4	1988	9.92
12	1908	10.8		1956	10.5	1992	9.96
16	1912	10.8		1960	10.2	1996	9.84
24	1920	10.8		1964	10.0	2000	9.87
28	1924	10.6		1968	9.95	2004	9.85
32	1928	10.8		1972	10.14	2008	9.69
36	1932	10.3		1976	10.06	2012	9.63

Source: *The World Almanac and Book of Facts 2001*; www.olympics.com

a. What observations can you make about this data by studying the table? times keep decreasing / there were no Olympics 3x due to war

b. Make a plot of the data. Are there any patterns that appear in the graph that you did not detect by looking at the table? Do you think a linear model would be a good fit for this data?

c. Calculate a linear regression model for this data. $t = -.0127y + 11.09$

d. Use your model from Part c to answer the following questions:

   i. What winning time would you predict for the 1940 Olympics? for the 2016 Olympics?

   $\nearrow 44$ $t = -.0127(44) + 11.09 \rightarrow \boxed{10.53s}$

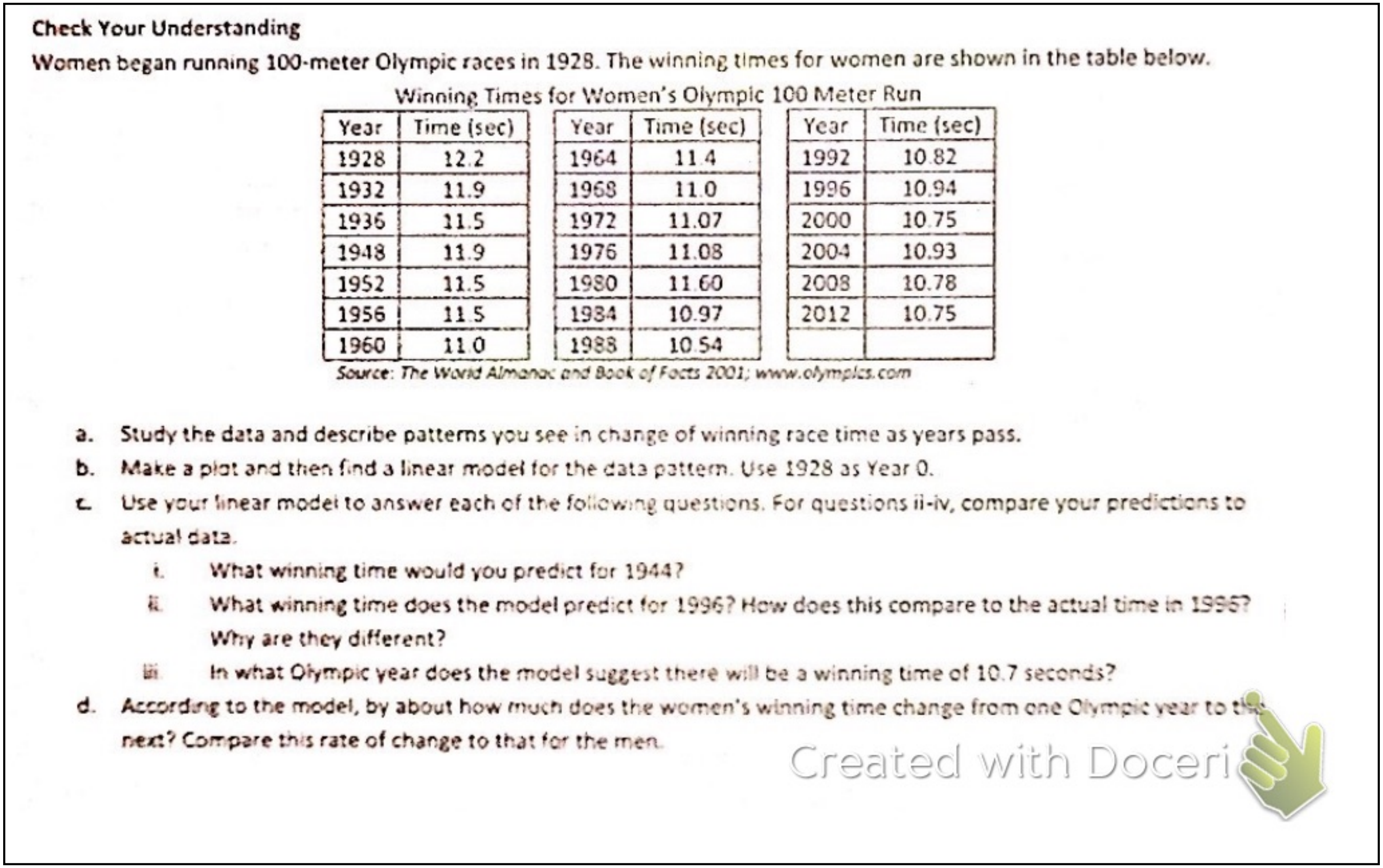
   $\rightarrow 120$ $-.0127(120) + 11.09 = \boxed{9.57s}$

   ii. In what year does your model predict the winning time to be 10.4 seconds? How does that compare to the actual data?

e. Complete the sentence below:

   On average, the winning times for the men's Olympic changes by _____ from year to year.

f. Do you have any doubts about the accuracy of your predictions for winning times [illegible] as the years pass?



Check Your Understanding

Women began running 100-meter Olympic races in 1928. The winning times for women are shown in the table below.

Winning Times for Women's Olympic 100 Meter Run

Year	Time (sec)
1928	12.2
1932	11.9
1936	11.5
1948	11.9
1952	11.5
1956	11.5
1960	11.0
1964	11.4
1968	11.0
1972	11.07
1976	11.08
1980	11.60
1984	10.97
1988	10.54
1992	10.82
1996	10.94
2000	10.75
2004	10.93
2008	10.78
2012	10.75

Source: The World Almanac and Book of Facts 2001; www.olympics.com

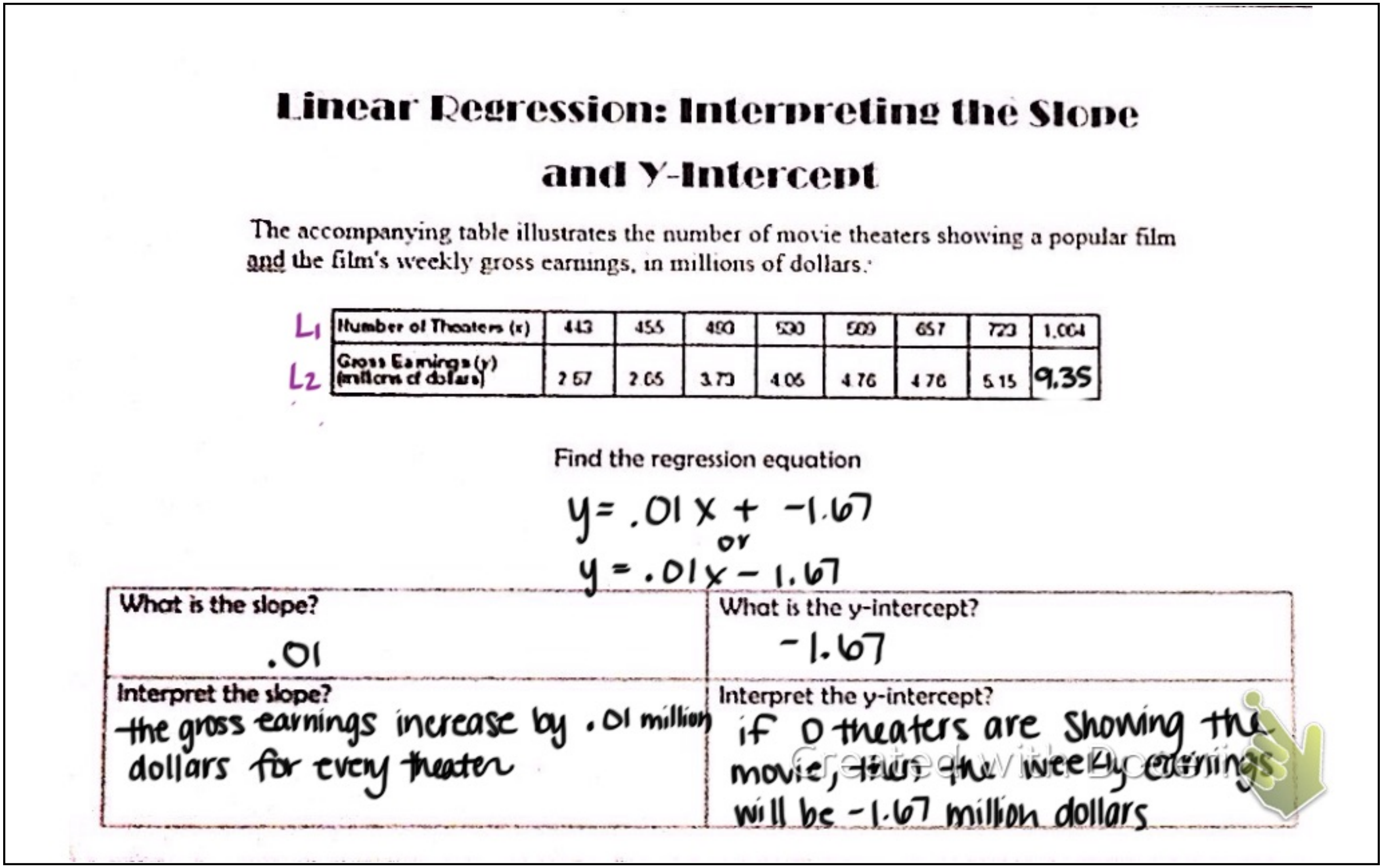
a. Study the data and describe patterns you see in change of winning race time as years pass.

b. Make a plot and then find a linear model for the data pattern. Use 1928 as Year 0.

c. Use your linear model to answer each of the following questions. For questions ii-iv, compare your predictions to actual data.

- i. What winning time would you predict for 1944?
- ii. What winning time does the model predict for 1996? How does this compare to the actual time in 1996? Why are they different?
- iii. In what Olympic year does the model suggest there will be a winning time of 10.7 seconds?

d. According to the model, by about how much does the women's winning time change from one Olympic year to the next? Compare this rate of change to that for the men.



Linear Regression: Interpreting the Slope and Y-Intercept

The accompanying table illustrates the number of movie theaters showing a popular film and the film's weekly gross earnings, in millions of dollars.

L1	Number of Theaters (x)	443	455	490	530	569	657	723	1,064
L2	Gross Earnings (y) (millions of dollars)	2.57	2.65	3.73	4.06	4.76	4.76	5.15	9.35

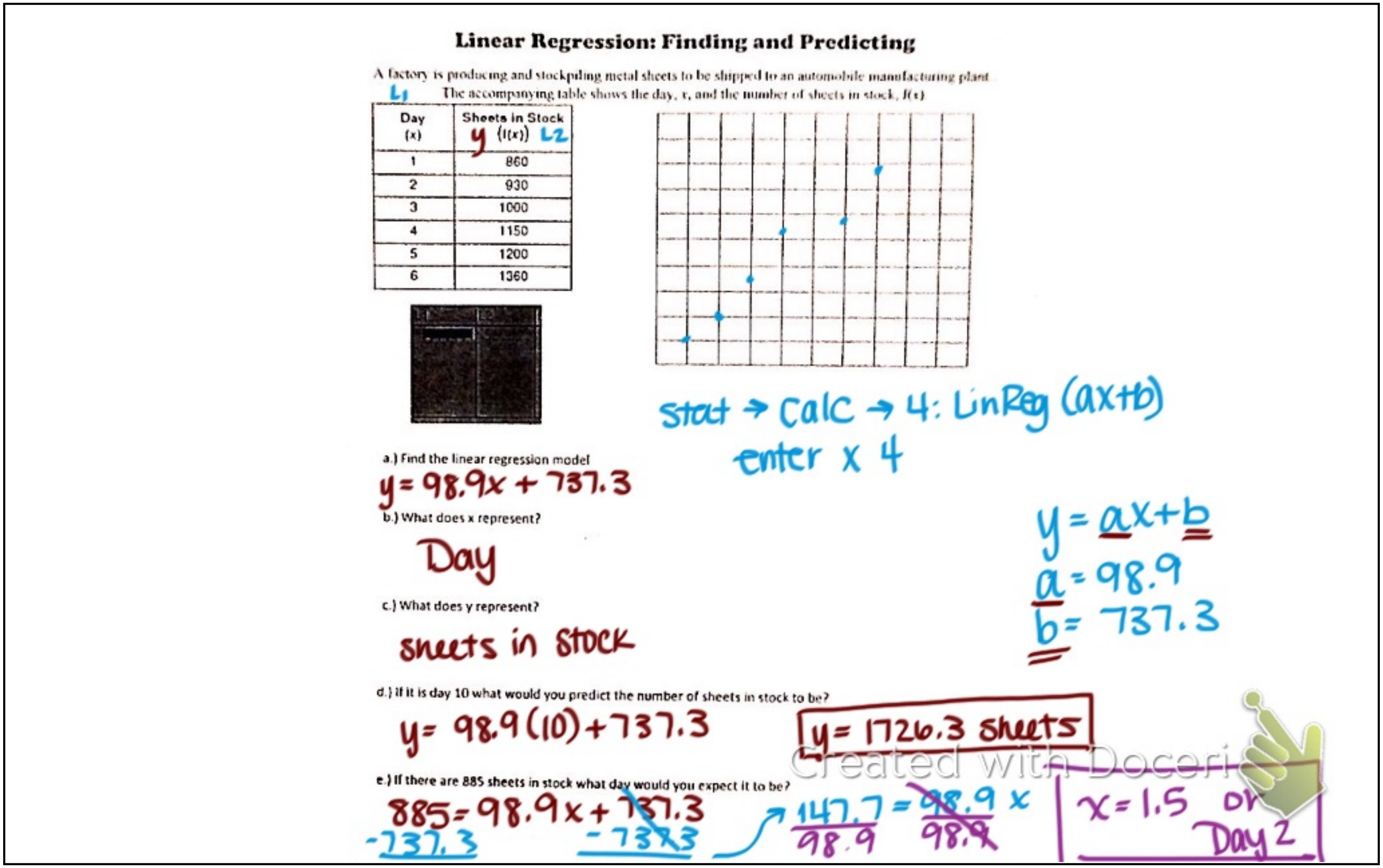
Find the regression equation

$y = .01x + -1.67$

or

$y = .01x - 1.67$

What is the slope? .01	What is the y-intercept? -1.67
Interpret the slope? the gross earnings increase by .01 million dollars for every theater	Interpret the y-intercept? if 0 theaters are showing the movie, then the weekly earnings will be -1.67 million dollars



Linear Regression: Finding and Predicting

A factory is producing and stockpiling metal sheets to be shipped to an automobile manufacturing plant. L1 The accompanying table shows the day, x, and the number of sheets in stock, f(x).

Day (x)	Sheets in Stock y (f(x)) L2
1	860
2	930
3	1000
4	1150
5	1200
6	1360

stat → calc → 4: LinReg (ax+b)

enter x 4

a.) Find the linear regression model

$y = 98.9x + 737.3$

$y = \underline{a}x + \underline{\underline{b}}$

$\underline{a} = 98.9$

$\underline{\underline{b}} = 737.3$

b.) What does x represent?

Day

c.) What does y represent?

sheets in stock

d.) If it is day 10 what would you predict the number of sheets in stock to be?

$y = 98.9(10) + 737.3$

$\boxed{y = 1726.3 \text{ sheets}}$

e.) If there are 885 sheets in stock what day would you expect it to be?

$885 = 98.9x + \cancel{737.3}$

$\underline{-737.3} \qquad \underline{\cancel{-737.3}}$

$\dfrac{147.7}{98.9} = \dfrac{\cancel{98.9}x}{\cancel{98.9}}$

$\boxed{x = 1.5 \text{ or Day 2}}$