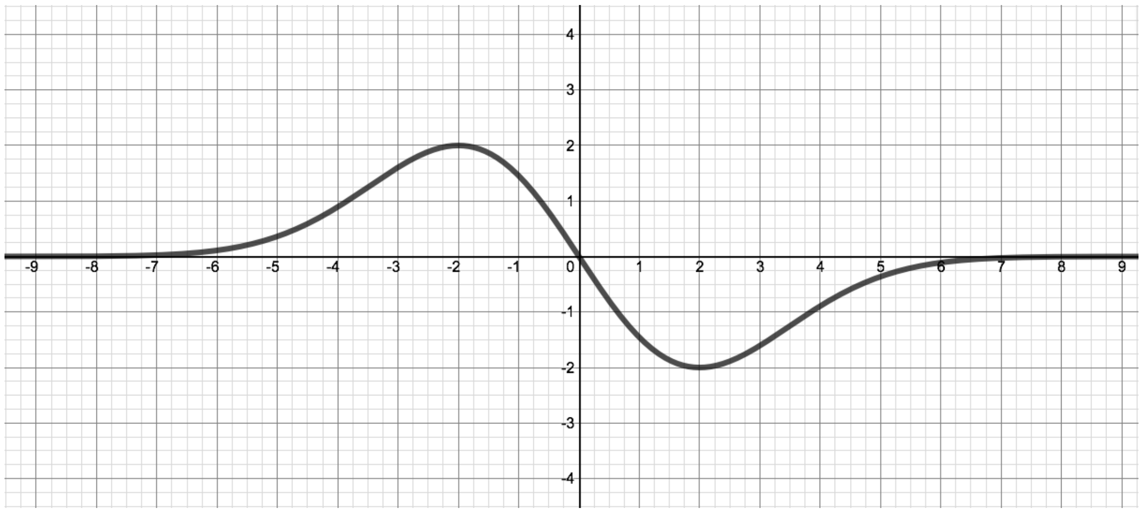
Name : ____________________ **Class Number:** _____

1. Let $f(x)$ be a function. The graph below is of the derivative $f'(x)$. Use it to solve this problem.



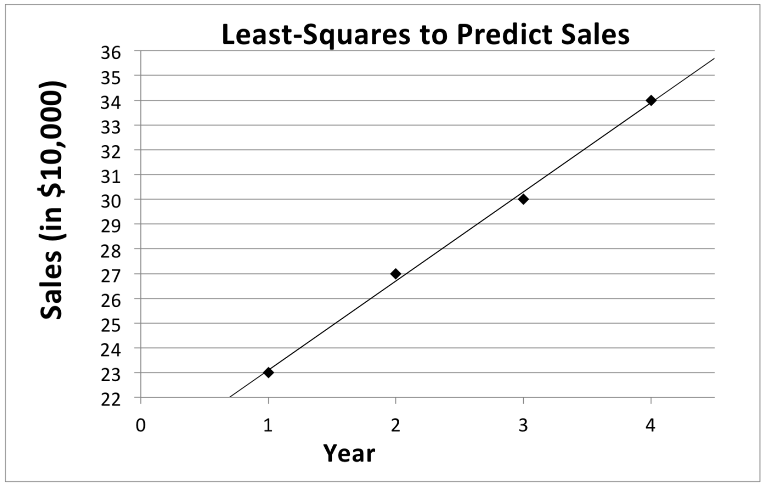
a. Identify the intervals on which $f(x)$ is concave up and concave down. Justify your answers.

b. Identify the intervals on which $f(x)$ is increasing and decreasing. Justify your answers.

c. Identify the extreme values of the function $f(x)$ using the <u>second derivative test</u>. Justify your answer.

2. A small bike company selling utility bicycles for daily commuting has been in business for four years. This company has recorded annual sales (in tens of thousands of dollars) as follows:

Year	Sales (in \$10,000)
1	23
2	27
3	30
4	34



This data is plotted in the figure next to the table above. Although the data do not exactly lie on a straight line, we can create a linear model to fit this data.

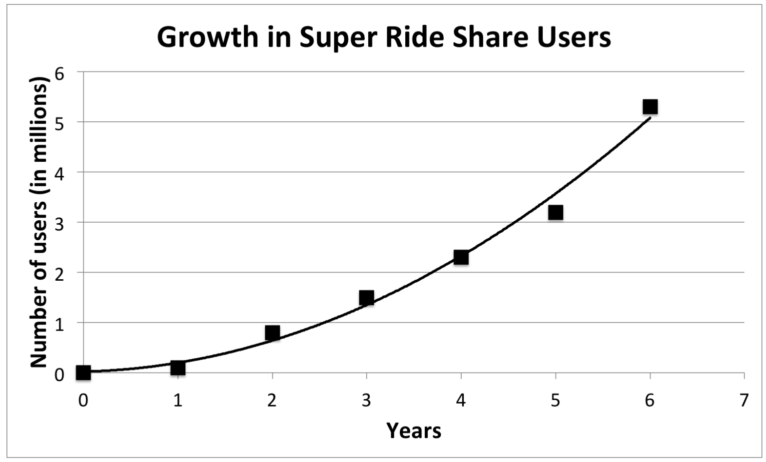
a. For the set of 4 data points given above in the form $\{(t_i, y_i)\}_{i=1}^{4}$, assume this data can be approximately modeled by a line $y(t) = mt + b$. For each data point, describe how to form the error $e_i(m, b)$ between the collected output y_i and the modeled output $y(t_i)$.

b. Using the model for the errors, set up the least-squares problem for this input data. In particular, create a two variable function $E_2(m, b)$ that you can use to solve create the “best-fit” model for this data. Explain in detail the choices that you made to construct your error function E_2.

c. Describe how we will use multivariable calculus to create the line of best fit.

3. A ride-sharing app called Super was recently released in 2009. During the first six years of it's business operations, the Super app has seen spectacular growth in its number of users:

Year	Number of Users (in Millions)
0	0.0
1	0.1
2	0.8
3	1.5
4	2.3
5	3.2
6	5.3



a. For the set of 7 data points given above in the form $\{(t_i, y_i)\}_{i=1}^{7}$, assume this data can be approximately modeled by a quadratic function

$$y(t) = a_0 + a_1 t + a_2 t^2$$

for unknown constants a_0, a_1, a_2. For each data point, describe how to form the error $e_i(m, b)$ between the collected output y_i and the modeled output $y(t_i)$.

b. Using the model for the errors, set up the least-squares problem for this input data. In particular, create a two variable function $E_2(a_0, a_1, a_2)$ that you can use to solve create the "best-fit" model for this data. Explain in detail the choices that you made to construct your error function E_2.