

**Exercise 1:**
The picture below shows the graph of a linear function used to model yearly US industrial carbon dioxide emissions, in million metric tons, between 2004 and 2008.

(a) The horizontal side of the triangle in above picture indicates the increase of the input by 1. Estimate the length of the vertical side of that triangle. This tells you how much the "height" of the graph increases when you move one input unit to the right.

(b) Use your result from part (a) to make a correct statement about how fast yearly US industrial carbon dioxide emissions change.

(c) Based on the picture and on what you found so far, construct a formula for a function which models yearly US industrial carbon dioxide emissions between 2004 and 2008.

**Exercise 2:** Goal: How one can see fast/slow growth of a quantity in a graph:

**Draw the graph of the size of a population over a period of time, given that the population**

(1) grows slowly at first
(2) then grows more quickly for a while
(3) then grows slowly again
(4) and decreases slowly, and then quickly in the end...
Exercise 3: College Tuition:

**College A:** Tuition increases by $300 each year (according to a Linear Model fit to data)

**College B:** Tuition increases by $650 each year (according to a Linear Model fit to data)

**College C:** Tuition increases by $1000 each year (according to a Linear Model fit to data)

Into the coordinate system below, draw one possible graph for each of the three colleges:

Use triangles (as in Exercise 1) to help identify which of the graphs belongs to which college.

(1) How fast the tuition increases does **not** affect the SHAPE of the graph(s). They are all straight!

What aspect of the described tuition scenarios causes the graphs to be **straight**?

(2) Describe in your own words how the **rate at which tuition increases** affects the graph.

Based on the tuition fees for the years 1992 - 2003 we found that the following Linear Model imitates the true tuition quite well for the indicated period 1992 - 2003:

\[ T = 5039.23 + 371.73 \cdot t, \]

where \( t \) is the number of years past 1992 and \( T \) is fall tuition in $.

(a) **How fast** did tuition grow between 1992 and 2003, according to this model?
   (answer in a complete sentence...)

(b) Explain in your own words **why** (how you know that) your answer for (a) is correct.
   ("Because some teacher told me so" is not a valid response.)

(c) Sketch the graph of this Xavier Tuition Model into the picture of Exercise 3.
   Can you show where/how in this graph one can "see" how fast the Tuition grows?

Exercise 4 (Part B): Xavier Fall Tuition 2003 - 2011:

<table>
<thead>
<tr>
<th>year</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>tuition</td>
<td>9,425</td>
<td>10,050</td>
<td>10,925</td>
<td>11,635</td>
<td>12,330</td>
<td>13,125</td>
<td>13,950</td>
<td>14,650</td>
<td>15,115</td>
</tr>
</tbody>
</table>

How fast did Xavier Fall tuition grow during this 8 year period...

(a) ...based on looking at the first and last data point, only?

(b) ...based on averaging the actual growths for each year?

(c) ...based on a Linear Regression Model? (...which you need to find)
**Exercise 5a:**
The resale-value of a 5 year old 2010 car depends on how many miles it has been driven. The resale-value based on mileage is given in the following graph:

![Graph showing resale-value decreases with mileage.]

From this graph, express in words how fast the value decreases based on mileage. Show in the picture how you determined your answer.

**Exercise 5b:**
Assume that the graph below shows the relationship between the price for some item and how many a store-owner expects to sell weekly, depending on the price he charges. You see that as the price increases, demand decreases. How fast does the demand decrease as price increases? Express what you found in a complete sentence.

![Graph showing demand decreases with price increase.]

Number of units sold per week vs. price for one unit (\$)
**Exercise 5c:**
The graph below shows the relationship between the speed of a car when the brakes are slammed and the length of the skidmark this maneuver will cause on the road. At what rate does the skidmark length increase with speed? Show work, and answer with a complete and meaningful sentence (or two.)

![Graph showing skidmark length vs speed](image)

**Exercise 6:**
Rewrite the following statements in such a way that they address how "rapidly", how "quickly", or "at what rate" the quantity under investigation changed.

(a) "The child grew ten inches over the past four years"

(b) "The student intern hired to count how many cars drive by counted 818 cars in 4 hours"

To see that such statements make sense even if time is not involved:

(c) "For the 50,000 people that have moved into the area recently, our air pollution level has gone up by 100 ppm (parts per million)."

(d) On a certain spring day temperature measurements were taken at different altitudes. At the altitude of 7000 feet, the temperature was 14°F. At the altitude of 27,000 feet, the temperature was -62°F. Make a statement about how quickly the temperature changes with altitude.
Exercise 7:
In Exercise 6, no straight-line-graph and no Linear Model were given. But the information given was enough to draw a straight line which accommodates the information. **Draw such a straight line for each of the examples (a) - (d), and indicate where in the picture your answer to each of (a) - (d) can be seen.**
Exercise 8:
The table shows the monthly profit of an amusement park for various ticket prices:

<table>
<thead>
<tr>
<th>ticket price ($)</th>
<th>20</th>
<th>22</th>
<th>24</th>
<th>26</th>
<th>28</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>monthly profit (million$)</td>
<td>14.4</td>
<td>19.4</td>
<td>23.1</td>
<td>25.2</td>
<td>26</td>
<td>25.2</td>
</tr>
</tbody>
</table>

(a) Raising the ticket price increases the profit until the price of the ticket hits $28. If the ticket price rises to above $28, the profit declines. How can that be? Explain in your own words.

(b) Raising ticket price from 20$ to 26$ will increase the profit by how much? Express this same fact using a "rate". Answer in a complete sentence. (If no clue, go to (c).)

(c) Make a scatterplot of the data (on paper).
In this scatterplot, circle the two points for ticket prices $20 and $26. Draw a straight line through these two points. Where/how can you "see" the rate asked for in part (b)?
Exercise 9:
The graph below shows the number of McDonald's employees (in thousands) from 1987 through 1996. (Source: Hoover's company profiles, 1997)

a. Approximately, how rapidly did the number of employees grow between 1992 and 1996? (Begin, as usual, with finding how many employees were added during the 4 years...)

b. The rate you reported in (a) is related to some straight line. Add this straight line to the picture below, and show where the rate you gave for (a) can be "seen".

Exercise 10:
The annual sales of the Coca-Cola Company from 1987 through 1996 can be modeled by

\[ S(x) = -0.012x^3 + 0.218x^2 + 0.265x + 7.739 \] billion dollars, \( x \) years after 1987.

(a) What was the "change" in annual sales between 1987 and 1991.

(b) By what percentage did annual sales grow between 1987 and 1991?

(c) How fast did the annual sales change between 1987 and 1991?