

Linear Models

Learning Goals

- know the properties of linear graphs
- know how to use the equation and table of values to determine the shape of the graph
- relate an equation or a table of values to real world problems

Linear Model

- shows equal changes over equal intervals

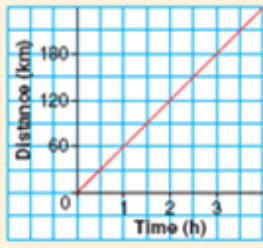
- the equation is $y=mx+b$

m is the rate of change *or slope*
b is the y-intercept

- straight line

- used to predict trends

Distance Travelled by a Car

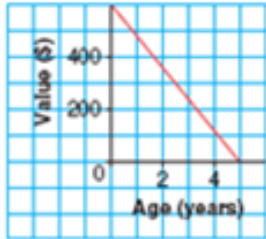


Rate of change is positive.

As time is increasing the distance driven is increasing.

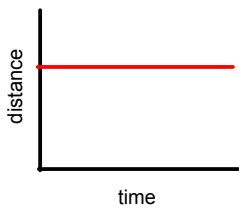


Depreciation in Value of Printer



Rate of change is negative.

As the printer gets older the value of it decreases.



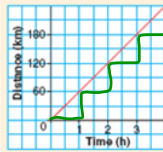
Rate of change is zero.

As a car is standing at a red light, as time increases the distance travelled is staying the same.

Handout

Linear models represent quantities that change at a constant rate over equal intervals.

Distance Travelled by a Car



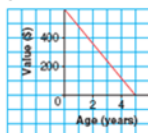
In a table of values the 1st differences are same.

Hours	Earnings (\$)	First Differences
0	0	
+5	40	40
+5	80	40
+5	120	40

Note
x values must go up by the same amount.

The graph is a straight line

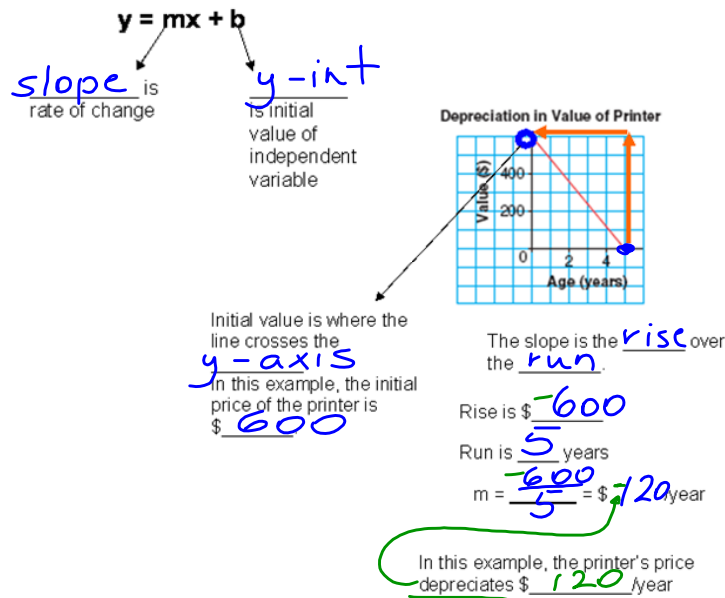
Depreciation in Value of Printer



Analyzing Linear Models

In real world applications of linear models:

- The x-axis represents the independent variable.
- The y-axis represents the dependent variable.



Comparing Pairs of Linear Relations

Example: A cup of coffee is reheated using the microwave. The temperature, C degrees Celsius, of the coffee after t seconds is modelled by the following equations:

- 500-W power setting:** $C = 0.5t + 20$
- 1000-W power setting:** $C = 1t + 20$



a) What do these equations tell you about the graph?
in front of t

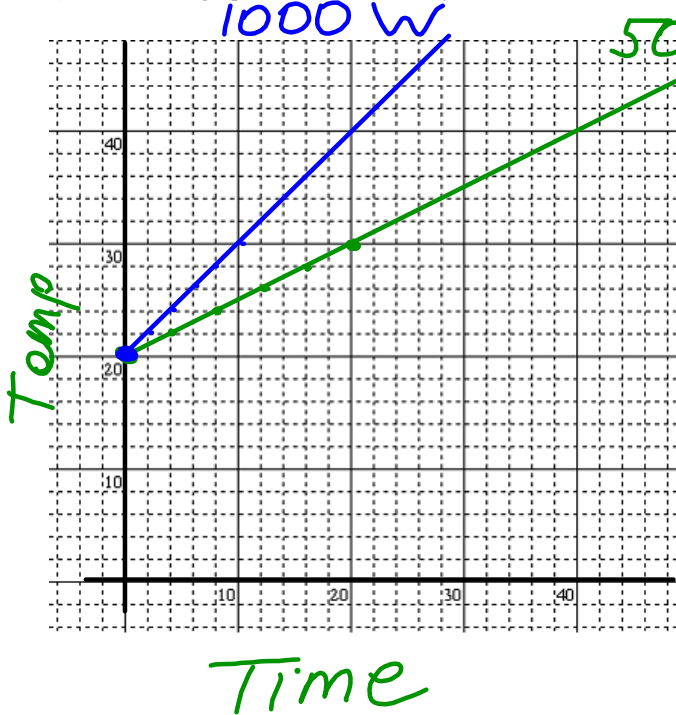
The coefficient of t represents the rate of change in the temperature of the coffee.

- The **500-W setting** has a 0.5 °C/second increase in temperature.
- The **1000-W setting** has a 1 °C/second increase in temperature.

The y-int explains the initial temperature of the coffee.

- The **500-W setting** started with the coffee at 20 °C.
- The **1000-W setting** also started with the coffee at 20 °C.

b) What do the graphs show about these functions?

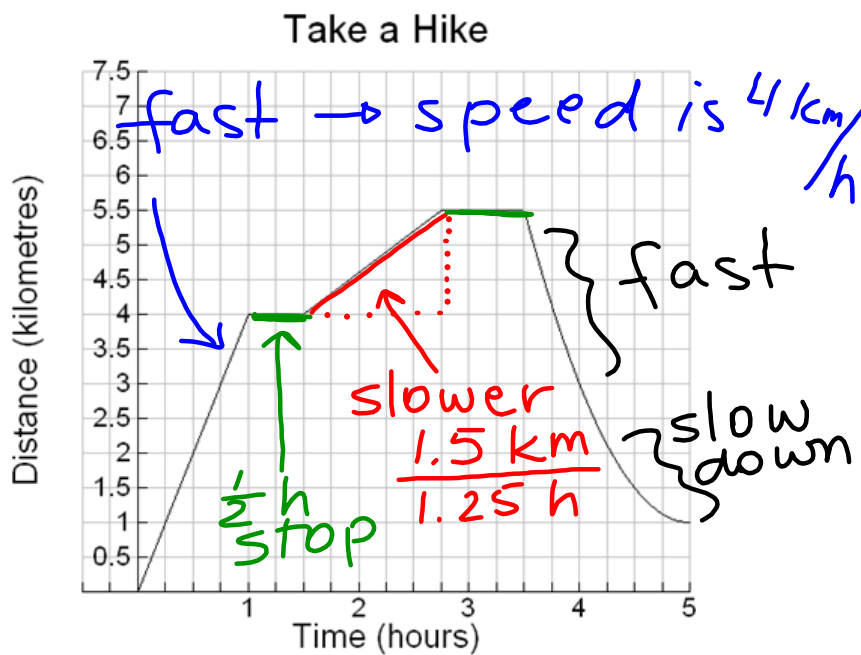


The y- intercepts are same, meaning that the coffees both started at the same temperature (20°C).


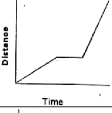
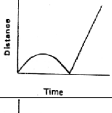
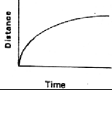
However, the 1000-W setting line is steeper than the 500-W setting line, meaning that this microwave increased the coffee's temperature at a faster rate.

What does this graph mean?
Can you write a story?

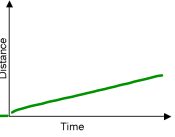
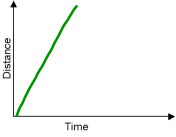
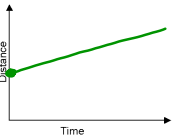
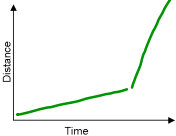
Dist.
Time
Speed



6. Below are four stories about walking from your locker to your class. Two of the stories correspond with two of the graphs. You must: match the graphs with their stories if possible; write stories for the remaining two graphs; draw a graph for the remaining two stories.

Stories	Story	Graphs
1. I was standing at my locker and started to walk to class, but I realized I had forgotten my notebook so I went back to my locker and then I went quickly to class.		
2. I was rushing to get to class when I realized I wasn't late so I slowed down a bit.		
3. I started walking to class and then I realized I was late so I ran the rest of the way.		
4. I walked slowly to class, but when I got there I realized that I had forgotten my textbook. I ran back to my locker, got my book, and then ran back to class.		
5.		
6.		

5. Using the description provided, draw the graph

<p>A. Walk slowly away from the CBR at a constant speed</p> 	<p>B. Walk quickly away from the CBR at a constant speed</p> 
<p>C. Start <u>farther away</u>, then walk slowly from the CBR at a constant speed</p> 	<p>D. Start by walking slowly away from the CBR, but then speed up</p> 

Fitting Regression Models to Data

We can use linear regression to model data that appear to relate in this way.

- The regression line or curve can be fitted to the data points and used to make a line of best fit.
- The closer the line or curve is to the data points, the more accurate the predictions are likely to be.

Linear Model Example

The following table shows the median age of Canada's population from 1975-2000.

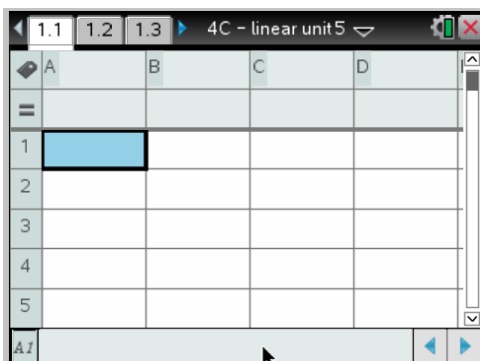
Year	1975	1980	1985	1990	1995	2000
Median age (years)	27.4	29.1	31.0	32.9	34.8	36.8

•Using a graphing calculator:

- a) Create a scatter plot and describe any trends.

1. Enter data into table of values

lists and spreadsheets

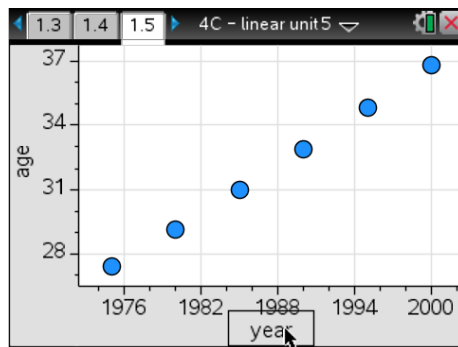
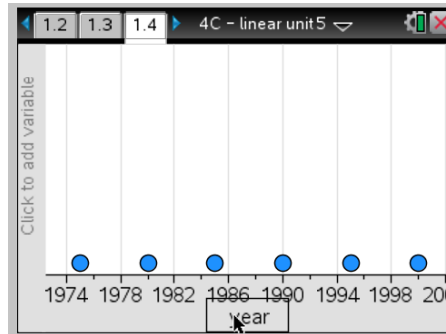
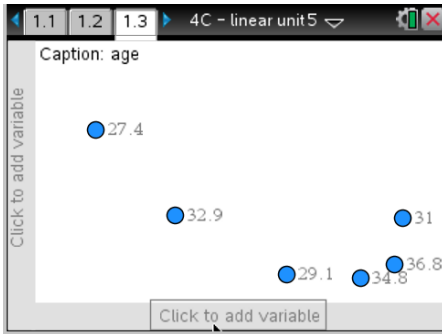


A screenshot of a TI-84 Plus calculator's spreadsheet editor showing data entered into the spreadsheet. The window title is "4C - linear unit 5". The spreadsheet has columns labeled A, B, C, and D, and rows numbered 3 through 7. Cell C4 is highlighted in blue.

A	year	B	age	C	D
3	1985	31			
4	1990	32.9			
5	1995	34.8			
6	2000	36.8			
7					

2. Make a graph - data

doc
insert
data + stats



straight
line
constant
rate

3. Find Linear Regression

Menu

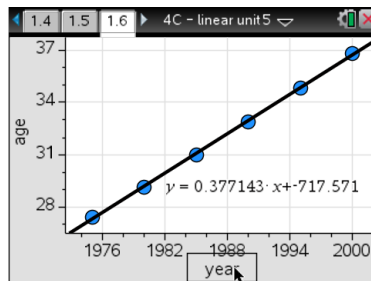
Analyse Graph

Regression

Linear $mx+b$

→ line of best fit

4. Use the equation to make predictions.



$$\begin{aligned}
 y &= 0.377x + 717.6 \\
 &= 0.377(2020) + 717.6 \\
 &= 43.94 \\
 &\therefore \text{age will be 44 years}
 \end{aligned}$$

Seatwork

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