# Analysing Graphical Models II

**Learning Goals**

- able to determine the type of graph needed
- able to use table of values and graphs to solve real life questions

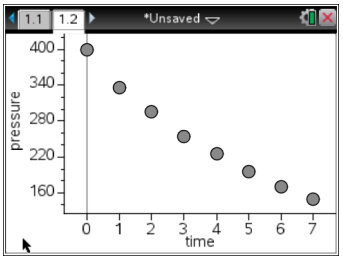
**Investigating a Leaky Tire**

Larry has a car tire with a slow leak. He measures the tire pressure every day for a week and records the following data:

| Time, $t$ (days) | Pressure, $P$, (kPa) |
|---|---|
| 0 | 400 |
| 1 | 335 |
| 2 | 295 |
| 3 | 255 |
| 4 | 225 |
| 5 | 195 |
| 6 | 170 |
| 7 | 150 |

0.882
0.86
0.8717
150÷170
=0.882

1. Graph the tire data using technology. Sketch the graph in the space below:




ratio 0.88 ∴ exponential

2. What kind of relationship seems to exist between time and pressure? Justify your answer.

As time increases the pressure decreases.

3. Determine the rate of change of pressure in this data using growth/decay factors. You may wish to add a column to the data table to record your results. What does this tell you about the data?

## Instructions for graphing calculator

### Table of values

- new document
- lists and spreadsheets
- enter data in spreadsheet

### Graph

- doc
- insert page
- data and statistics
- choose labels for axis

### Line of best fit

- menu
- analyse graph
- regression --- choose linear, quadratic or exponential

4. Perform a regression analysis of the data on your graphing calculator using linear, quadratic, and exponential models. Record your results below giving the equation for each model. Sketch a graph of each model along with the data points.

Linear Equation: _____

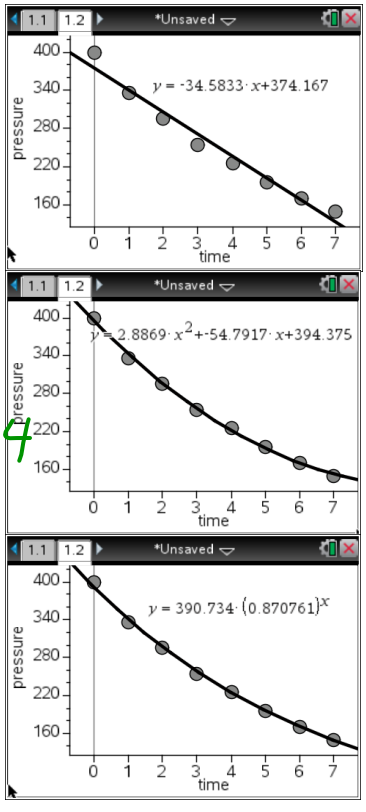
$y = -34.6x + 374$

Quadratic Equation: _____

$y = 2.9x^2 + 55x + 394$

Exponential Equation: _____

$y = 391(0.87)^x$



4. Which model best represents this data? Justify your answer.

exponential → same ratios

5. Use your best model equation to answer the following questions. Show your work.

a) What will the pressure be after 10 days? 20 days?

$y = 391(0.87)^x$

$y = 391(0.87)^{10}$

$y = 97.13$

$y = 391(0.87)^{20}$

$= 24.13$

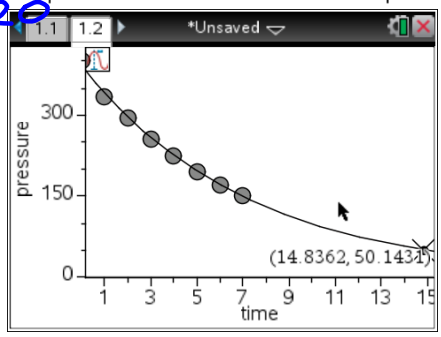
b) How long will it take for the pressure to drop to 50 kPa?

$50 = 391(0.87)^x$

→ solve($50 = 391(0.87)^x$, $x$)

$x = 14.76$

c) When will the pressure drop to zero?




Mathematically zero is never reached

**Practise**

1) **Complete the following analysis in your notes to determine whether a linear, quadratic or exponential model best represents the data.**

This data gives the population growth of bacteria cells in a petri dish that was inoculated by a swab from an infected wound:

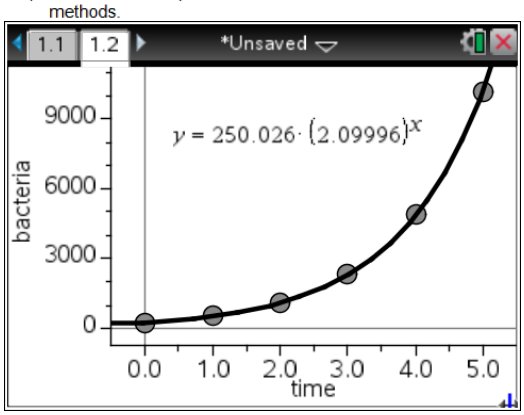
| Time, $t$ (hours) | Number of bacteria cells | ratio |
|---|---|---|
| 0 | 250 | |
| 1 | 525 | 2.1 |
| 2 | 1103 | 2.1 |
| 3 | 2315 | 2.1 |
| 4 | 4862 | 2.1 |
| 5 | 10210 | |

∴ exponential

a) Sketch the graph. Use graphing technology if available.

b) Determine the rates of change in bacteria population.

c) Determine the equation that best models this data. Use technology or algebraic methods.



d) Use your equation to answer the following questions:
i) What will the bacteria population be after 12 h? 2 days?
ii) When will the population reach 1 million?
iii) In real life, will the bacterial population continue to grow like this?

12 h
$y = 250.03(2.10)^{12}$
$= 1\,839\,178$

2 days
$y = 250.03(2.10)^{48}$
$= 7.3 \times 10^{17}$

$1\,000\,000 = 250(2.10)^{x}$
$x = 11.2$

No → food
temperature
size of petrie dish
...

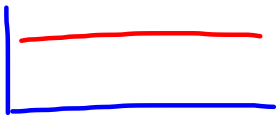
e) Instead of growing as shown in the table above, the bacteria started with 250 cells and increased by a constant amount of 250 cells each hour. What type of equation would model this data?

f) Now suppose that the number of cells in the petri dish remained constant at 250 no matter how much time passed. What type of equation would model this data? Sketch a graph.

e.) constant increase → linear

$y = 250x + 250$

f.) stay constant → linear



$y = 250$

$P = P_0(1+r)^n$

**2) The compound interest formula is $A = P(1 + i)^n$ where A is the amount with interest, P is the principal (or starting amount), i is the interest rate as a decimal, and n is the number of compounding periods.**

**Each of the following scenarios uses the compound interest formula. For each, complete the table of values and graph the function. Then, identify whether the function is linear, quadratic or exponential.**

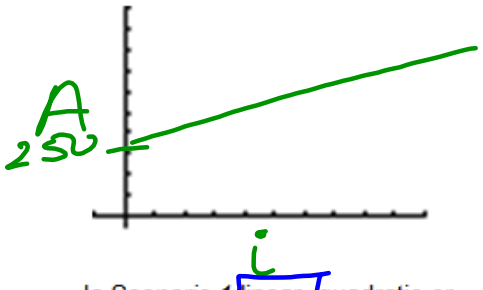
*Scenario 1 – One Year*: Bonita plans to deposit $250 in a savings account. She wonders what relationship exists between the interest rate of the savings account and the amount of money she will have at the end of one year.

The compound interest formula for one year is: **$A = 250(1 + i)^1$**

Complete this table of values.
Calculate the finite differences.

| i | A | Finite differences |
|---|---|---|
| 0.02 | 255 | ---------- |
| | | 5 |
| 0.04 | 260 | |
| | | 5 |
| 0.06 | 265 | |
| | | 5 |
| 0.08 | 270 | |
| | | 5 |
| 0.10 | 275 | |
| | | 5 |
| 0.12 | 280 | ---------- |

Sketch the graph. Label the axes!




Is *Scenario 1* linear, quadratic or exponential? How do you know?

1st diff are same

*Scenario 2 – Two Years*: Bonita still plans to deposit $250 in a savings account. She now wonders what relationship exists between the interest rate of the savings account and the amount of money she will have at the end of two years.

The compound interest formula for two years is: **$A = 250(1 + i)^2$**

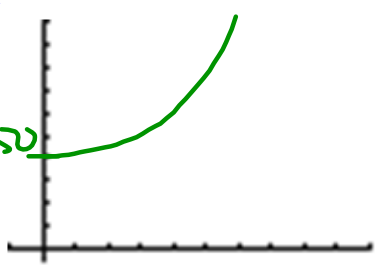
Complete this table of values.
Calculate the finite differences.

| i | A | Finite differences |
|---|---|---|
| 0.02 | 260 | ---------- |
| | | 10.3 |
| 0.04 | 270 | |
| | | 10.5 |
| 0.06 | 281 | |
| | | 10.7 |
| 0.08 | 292 | |
| | | 10.9 |
| 0.10 | 303 | |
| | | 11.10 |
| 0.12 | 314 | ---------- |

2nd

0.2
0.2
0.2
0.2

Sketch the graph. Label the axes!




Is Scenario 2 linear, quadratic or exponential? How do you know?

2nd diff are same

*Scenario 3 – Unknown Time*: Bonita deposits $250 in a savings account with an interest rate of 6%. She wonders what relationship exists between the number of years the money is compounded, and the interest rate.

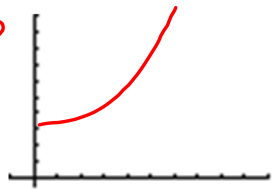
The compound interest formula for 6% for a unknown time is: $A = 250\ (1 + 0.06)^n$
$A = 250\ (1.06)^n$

Complete this table of values.
Calculate the finite differences.

| n | A | Finite differences |
|---|---|---|
| 0 | 250 | ---------- |
| | | 15 |
| 1 | 265 | |
| | | 15.9 |
| 2 | 281 | |
| | | 16.86 |
| 3 | 298 | |
| | | 17.86 |
| 4 | 316 | |
| | | 18.9 |
| 5 | 335 | ---------- |

ratio
1.06
1.06
1.06
1.06

Sketch the graph. Label the axes!



Is *Scenario 3* linear, quadratic or exponential? How do you know?

ratios are the same

Which variable(s) in the formula $A = P\ (1 + i)^n$ did you set to a constant to create a linear equation? a quadratic equation? an exponential equation?

linear $n = 1$
quadratic $n = 2$
exponential $i = 0.06$

Which variable(s) in the formula $A = P\ (1 + i)^n$ did you set to a constant to create a linear equation? a quadratic equation? an exponential equation?

# Seatwork

pg 325 # 9, 10, 11, 12