RÉGION ACADÉMIQUE
PAYS DE LA LOIRE
MINISTÈRE
DE L'ÉDUCATION NATIONALE
MINISTÈRE
DE L'ENSEIGNEMENT SUPÉRIEUR,
DE LA RECHERCHE
ET DE L'INNOVATION

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# Let's work in the City !

Paul, a young French trader, wants to work in the City (London).

He has applied for a job in two companies, has been interviewed, and has finally been offered a job in both companies. Now he has to choose between the two job offers.


<u>Conditions of the job offer in company A</u>:

Start of the contract : 01/01/2017
Monthly salary : £ 4,500
Each year, on the 1st of January, the monthly salary increases by £60.

<u>Conditions of the job offer in company B</u>:

Start of the contract : 01/01/2017
Monthly salary : £ 4,200
Each year, on the 1st of January, the monthly salary increases by 3%.

**1)** How could you model the salary of each offer?

**2)** What will Paul's annual salary be in 2025 if he chooses company A?

**3)** When will Paul's annual salary reach £60,000 if he chooses company B?

**4)** Paul plans to stay for eight years in London. Figure out which job offer would be the most interesting for him.

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# Malthus's theory

Thomas Malthus (1766-1834) was an English political economist who was concerned about what he saw as the decline of living conditions in nineteenth century England.
Malthus published «An essay of the Principle of Population » in 1798. He blamed this decline on the rising of human population and the inability of feed resources. According to Malthus, the population will increase by 3% every year and the feed resources will increase by 0.48 million every year.

| Year | Population (million) | Feed resources (million of people) |
|---|---|---|
| 1800 | 10 | 12 |
| 1801 | 10.3 | 12.48 |
| 1802 | 10.609 | 12.96 |

**1)** According to Malthus's theory:

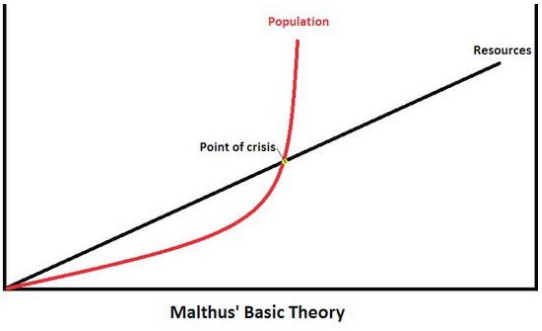
- **a)** Which kind of sequence P describes the population growth? Give its characteristics.
- **b)** Deduce the population in 1830 and in 1850.
- **c)** When did the population amount to 30 million?

**2)** According to Malthus's theory:

- **a)** Which kind of sequence R describes the feed resources growth? Give its characteristics.
- **b)** How many people did the resources feed in 1830 and in 1850?
- **c)** When did the resources feed more than 40 million people? Use an algebraic method.

**3)** Here is a graph extract from Malthus's essay:

When did what Malthus predicted as « the point of crisis » occur? Use your calculator.



Malthus' Basic Theory

**4)** Actually, the following table shows real population growth in England during the nineteenth century.

How can you explain such a difference between Malthus's theory and reality?

| Year | 1800 | 1820 | 1840 | 1860 | 1880 | 1900 |
|---|---|---|---|---|---|---|
| Population (million) | 10 | 15.5 | 20.2 | 24.5 | 33 | 41.5 |

http://blogs.isb.bj.edu.cn/fional/thomas-robert-malthus/

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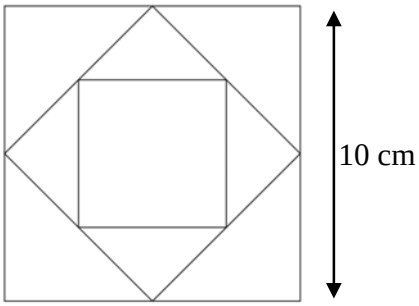
# Ancient tiles

John is designing tiles. To make them a little bit more attractive, he draws a black line along the perimeter.
He gets carried away, and joins the midpoints of the sides to form another square, then another one…
(as you can see on the drawing ).

www.haaretz.com/archaeology

*Evidence of such tiling have recently been found in Israel. They are believed to date from 37 to 4 BC during the reign of Roman vassal King Herod.*
*They were used to decorate roofed colonnades on the top of the Temple Mount.*

The tile has the shape of a square with 10 cm long sides.




**1)** Find the expression of the first three perimeters of the squares you can see in the drawing.
**2)** What is the expression of the perimeter of the tenth square John would draw?
**3)** Can you give the total length of the black line used to mark the different squares, if John draws 10 of them?

**If you have time:**

At a working distance of 30 cm, John can't distinguish anything which is less than 0.5 mm long.
Can you say how many squares he will be able to draw before he has to stop?

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# The pig pen

Suppose a rectangle pig pen is 4 feet longer than it is wide and its area is more than 32 square feet.
The question is the dimensions of the pen.
Let $x$ represent the width of the pen.

**1)** Using $x$, give the pig pen length and area.
**2)** Explain why $x^2 + 4x - 32 > 0$.
**3)** Sketch the graph of the function $y = x^2 + 4x - 32$ and shade the $x$-values that satisfy the inequality $x^2 + 4x - 32 > 0$.
What could the dimensions be?

*Pig pen, Source :* Haley McCready Outreach and Development Fund *http://haleymccreadyfund.com/?m=201112*

The farmer gets more pigs and increases the dimensions of his pen. The pig pen is now 10 feet longer than it is wide and its area is exactly 96 square feet.

**4)** Explain why $x^2+10x-96=0$.
**5)** Solve this equation.
**6)** What are the new dimensions?

**If you have time**:
Explain how living condition of factory farming animals could be improved.

## Factory Farming: Misery for Animals

On today's factory farms, animals are crammed by the thousands into filthy, windowless sheds and stuffed into wire cages, metal crates, and other torturous devices. These animals will never raise their families, root around in the soil, build nests, or do anything that is natural and important to them. Most won't even feel the warmth of the sun on their backs or breathe fresh air until the day they're loaded onto trucks headed for slaughterhouses.

The factory farming industry strives to maximize output while minimizing costs—always at the animals' expense. The giant corporations that run most factory farms have found that they can make more money by squeezing as many animals as possible into tiny spaces, even though many of the animals die from disease or infection.

*Source: People for the Ethical Treatment of Animals (PETA)*
*http://www.peta.org/issues/animals-used-for-food/factory-farming/*

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# The path of a punted ball


*Buzzstard.com*

When a football player punts* a football, he hopes for a long "hang time". (Hang time is the total amount of time the ball stays in the air). A time longer than 4.5 seconds is considered good.

The height of the ball in feet after $t$ seconds can be modeled by the following function:

$$H(t) = at^2 + Vt + h$$

where $V$ is the initial velocity of the ball and $h$ is the initial height of the ball.

We suppose that a punter kicks the ball with an upward velocity of 80 feet per second and his foot meets the ball 2 feet off the ground.

The height of the ball is 98 feet after 2 seconds.

**1)** What is the hang time of the ball?

**2)** Conclude.

**3)** How could the football player increase his "hang time"?

* a punt is a kick in which the ball is dropped and then kicked before it touches the ground.

**If you have time:**

Source: The Guinness Book of Records

On September 21, 1969, Steve O'Neal set a National Football League record by punting the ball 98 yards.

Do you know other sports where the paths of projectiles, as well as their heights over time, can be modeled by quadratic functions?

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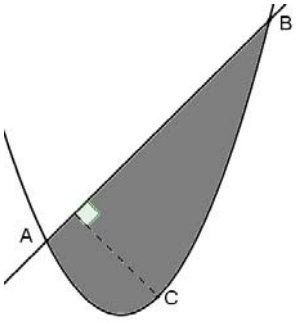
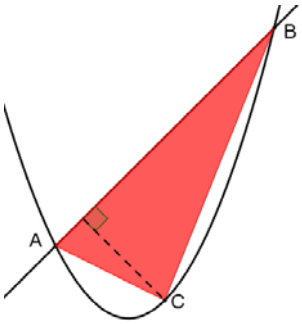
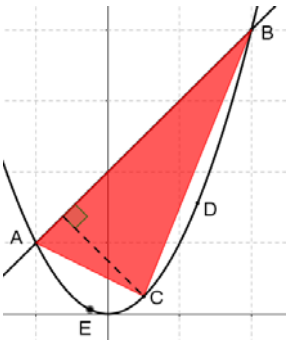
# Archimedes and Cupidon

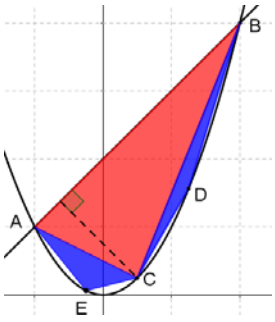


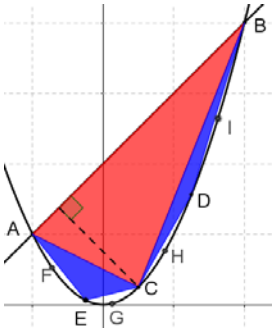



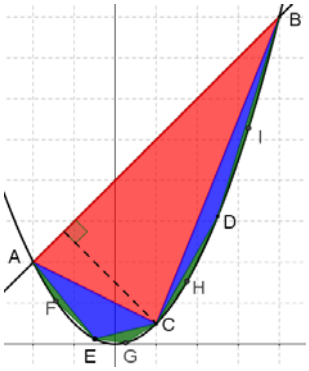

Two thousand years before the 17th century's mathematicians who developed differential calculus, Archimedes claimed that the area of a parabolic segment is 4/3 the area of a triangle with the same base and altitude.

What is remarkable is that he only computed polygonal areas as shown below:

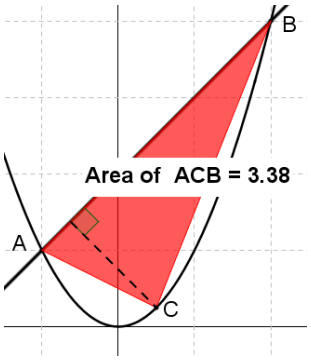


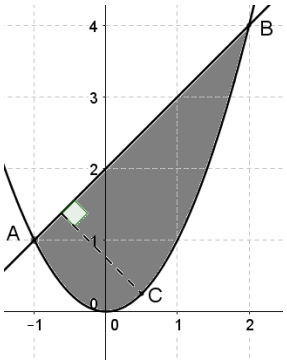



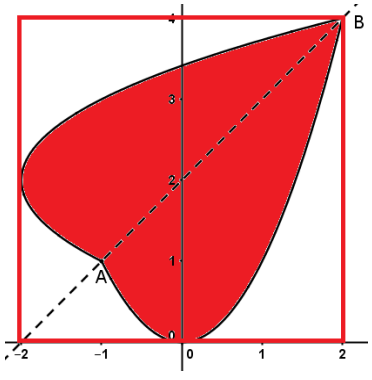




**1)** Try to explain his process with geometrical considerations.
**2)** On the example beside, and applying Archimedes' discovery, what is the area of the parabolic segment?
**3)** Young students of the 21st century in Maths European sections have tools to compute the area of parabolic segments. Check the value you got for question 2 (You've got two methods!).




**4)** Cupid had a nice idea using the parabolic segment. What is the area of his red heart?
**5)** Cutting it from a square piece of cardboard he was afraid of wasting half the cardboard he had. Was he right?



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# Broadway

The director of a famous Broadway theatre notices that the number of the audience members depends on the price of the ticket :

If the price is \$30, there are 500 persons in the audience.

Each increase of \$1 implies a loss of 10 persons.

**1)** What will the revenue be if the price of the ticket is \$32?

**2)** The director wants to find the best price to obtain the biggest profit.

If $n$ is the number of \$1 increases, show that the revenue is: $R(n) = -10n^2 + 200n + 15000$.

What is the best price? And what will the revenue be like for this price?

**3)** The director wants to earn \$15000 or more for each show. In which interval should he set the price of the ticket to reach his goal?


www.pixabay.com

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# The third royal baby


IBT. INDIA WORLD BUSINESS TECHNOLOGY SPORTS ENTERTAINMENT AUTO

News Entertainment Royalty

Kate Middleton third pregnancy rumours: Palace 'confirms' Duchess of Cambridge is having twin girls?

February 16, 2016 12:15 IST

By Shilpa Bansal

Kate Middleton and Prince William Reuters

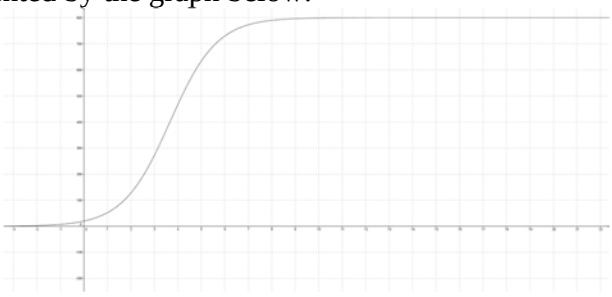
On Tuesday 16th February 2016, in the library of an American High school, a group of students read the article from IB TIMES:

Then they decided to start the rumour about "the third royal baby".

The spread of this rumour throughout the school could be modelled by the function: $n(t) = \frac{800}{1+39e^{-t}}$ where $n$ is the number of students who have heard the rumour as a function of time, $t$, in days.

**1)** Assuming that every student at school eventually hears the rumour, determine:
- **a)** The number of students in the library who started the rumour.
- **b)** The student population of the school.
- **c)** How long it will take for the rumour to reach half of the school's population.

**2)** This function is represented by the graph below:



- **a)** Explain why the shape of the curve is reasonable in the context.
- **b)** Why doesn't it keep rising exponentially?

**3)** Complete the table:

| Day | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Speed of the spread | | | | | | | | | |

- **a)** Determine the day when the rumour spread the fastest.
- **b)** Was this rumour true?

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# Life expectancy

| countries | 1960 | 2014 |
|---|---|---|
| USA | 70 | 79 |
| Canada | 71 | 81 |
| Mexico | 57 | 76 |
| Brazil | 54 | 74 |
| Argentina | 65 | 76 |
| Chile | 57 | 81 |
| France | 69 | 82 |
| UK | 71 | 81 |
| Germany | 69 | 80 |
| Norway | 73 | 81 |
| Romania | 65 | 75 |
| Greece | 68 | 81 |
| Japan | 67 | 83 |
| China | 43 | 75 |
| India | 41 | 68 |
| Australia | 70 | 82 |
| Indonesia | 48 | 68 |
| Iran | 44 | 75 |
| Afghanistan | 32 | 60 |
| Middle East and North Africa | 46 | 72 |
| Sub-Saharan Africa | 40 | 58 |
| South Africa | 49 | 57 |
| Russian Federation | 66 | 70 |
| Turkey | 45 | 75 |

2014


| 1960 | | 2014 |
|---|---|---|
| | 3 | |
| | 4 | |
| | 5 | 78 |
| | 6 | 088 |
| | 7 | 0245555669 |
| | 8 | 011111223 |

sources: http://data.worldbank.org/indicator/SP.DYN.LE00.IN?end=2014&name_desc=false&start=2014&view=map

The table and the map above display the life expectancies (in years) in several countries both in 1960 and 2014.

1) Fill in the back to back stem and leaf diagram above for year 1960.
2) For each year, calculate the mean and the five-number summary (the median, the lower quartile, the upper quartile, the minimum, the maximum).
3) Compare these two distributions and draw an appropriate conclusion. Try to work this out as accurately as possible.

**If you have time**:

Can you explain why Japan has the highest life expectancy and countries in Sub-Saharan Africa the lowest in 2014? Do you think that life expectancy will increase infinitely?

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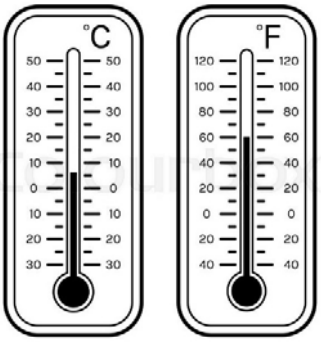
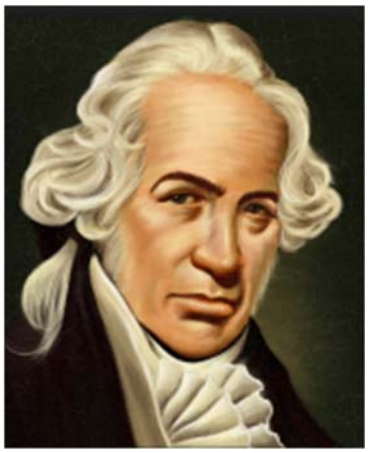
# Celsius versus Farenheit

Anders CELSIUS



Daniel FAHRENHEIT

Felicia, who was born in the United States and Carlo, of Spanish origin are sharing a flat in Paris where they are both studying French over the summer.
They don't use the same temperature scale: Felicia uses Fahrenheit degrees while Carlo uses Celsius degrees.
They decide to buy two different thermometers in order to choose suitable clothes each morning: a warm jumper or not…
When they leave the flat together at 9.00 am, they both write the temperature of the day on the fridge door. The measures are rounded to the nearest value.
Here is what they wrote last week:

| | Carlo | Felicia |
|---|---|---|
| Monday | 7 | 45 |
| Tuesday | 12 | 54 |
| Wednesday | 15 | 59 |
| Thursday | 11 | 52 |
| Friday | 17 | 63 |
| Saturday | 14 | 57 |
| Sunday | 10 | 50 |

**1)** Taking Carlo's column as X and Felicia's as Y and using your calculator, give the equation of the regression line to get Y with respect to X.
**2)** The French weather forecast is predicting 19 °C for the next Wednesday. Convert this temperature into Fahrenheit for Felicia.
**3)** Felicia tells Carlo that 70 °F is not so hot, what do you think of that?

**If you have time:**
Carlo is planning to visit Felicia next summer. Find the formula to help him convert °F into °C.