Épreuve de D.N.L. Mathématiques – Anglais session 2014
Sujet 3

You have to talk for ten minutes about this subject. Which mathematical notion(s) do you recognize?
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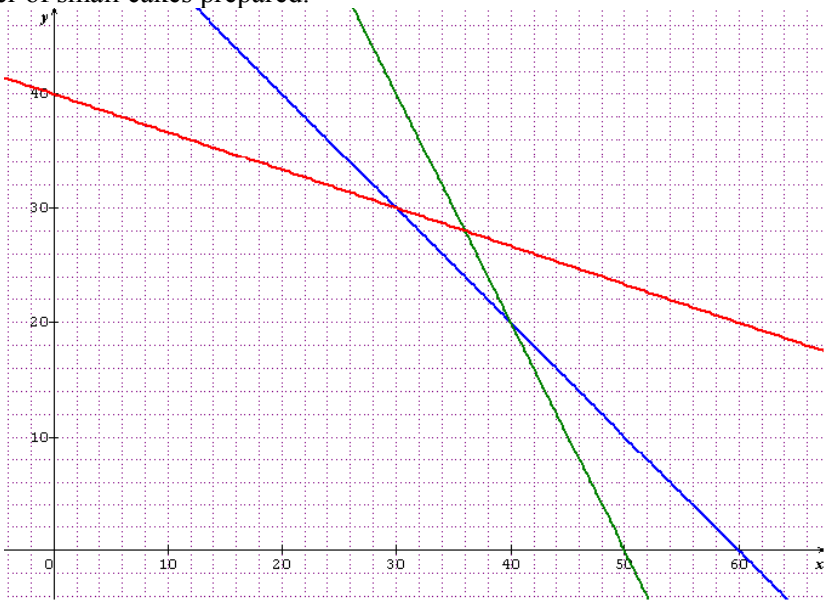
The cake study

A school class is planning a trip abroad. To raise some money, the pupils decide to sell cakes during school breaks next week. But they can't cook more than 60 cakes (small and big ones). One egg is enough to cook a small cake, but two are needed for big cakes. The pupils only have 100 eggs. Big cakes are quicker to prepare than small ones: 9 minutes are enough for a big cake, but 27 minutes are required for a small cake. Moreover, pupils can't spend more than 18 hours preparing cakes. The pupils made the following graph, where x refers to the number of big cakes, and y the number of small cakes prepared.



1) Explain why the pupils drew these lines.

2) Where is the domain of points satisfying the pupils' constraints?

3) Each big cake gives a profit of £3 and each small cake a profit of £2.
Let b be the total profit. Express b in terms of x and y.

4) What is the maximum profit they can make during the whole week? Explain.

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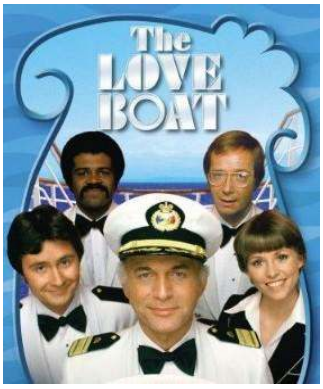
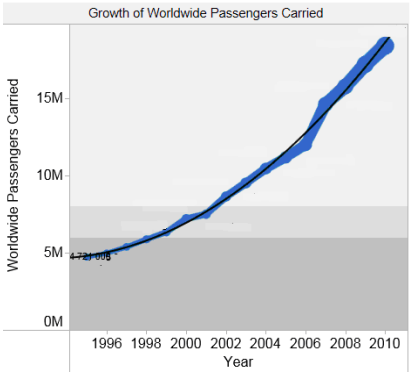


Worldwide, the cruise industry is steadily increasing. The average passenger annual growth rate from 1996 to 2010 is 9.5 %.
In 1996, 4,721,000 people took an ocean cruise.



1) Explain why this evolution can be modelled by a geometric sequence.
Let (a_n) be this sequence; give its characteristics.

2) How many people experienced cruise holidays in 1997? In 1998?

3) Compute the number of people who booked a cruise in 2010.

4) What is the total number of passengers carried from 1996 to 2010?

5) The Oasis III (code name: A34) is being built in Saint Nazaire. This ship will be launched in 2016; it will be the biggest cruise ship in the world, with a capacity of 5,400 passengers.

Let's assume that a cruise lasts 1 week.
How many ships of this size would be needed to carry the 22,980,000 passengers expected in 2016?

Sources :
http://www.cruisemarketwatch.com/growth/, http://www.royalcaribbean.fr/ et http://www.msccruises.ie/ie_en/homepage.aspx

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Sujet 8

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The cement factories

In its first months of operation a cement factory, A, produces 4,000 tons of cement. Then, production rises by 250 tons per month. This growth in production is illustrated for the first five months in the table below.

Month number (n)	1	2	3	4	5
Amount of cement produced (tons)	4,000	4,250	4,500	4,750	5,000

1) Which kind of sequence describes this situation?
   Give its characteristics.
2) In which month does the quantity of cement amount to 9,250 tons?

A second factory, B, starts production at exactly the same time as the first one. In its first month of production it produces 3,000 tons of cement. Then production increases by 8% per month.

3) Find an expression for the total amount of cement produced by this factory after n months.
   Let QA be the total amount of cement produced by factory A in the first n months, and QB be the total amount of cement produced by factory B in the first n months.

4) Find the smallest value of n for which $QB \geq QA$.

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Sujet 9

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We'd like to compare the annual amount of snowfall between two ski resorts over the past 50 years.

http://notre-vie-a-nous-3.skyrock.com/2978044167-marcinelle-en-montagne.html

	Median	Minimum value	Maximum value	lower quartile	upper quartile
Powder Valley (in inches)	175	75	325	125	250
Mad Mountain (in inches)	225	0	400	100	300

1) Construct two box-diagrams on the same horizontal scale for each ski resort.

2) Explain each of the values above and compare the two resorts.

3) What can you use to compare the variation of snowfall for the two resorts?

4) Which resort has the greater chance of receiving more than 300 inches of snow?

http://mjpontivy.canalblog.com/archives/2012/10/10/24123172.html

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Sujet 10

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Here are the heights, in inches, of plants grown using two different kinds of fertilizers.
Organic fertilizer: 23, 18, 38, 52, 46, 9, 36, 39, 40, 49, 50, 42, 47
Chemical fertilizer: 42, 51, 36, 29, 12, 46, 30, 9, 18, 16, 23, 28, 24

1) Make an ordered stem-and-leaf plot for each fertilizer.

2) In each data, how many plants are higher than 40 inches?

3) Find the mean, the median, the lower and upper quartiles of each set of data.

4) Which of the two fertilizers is more effective? Explain.

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Sujet 15

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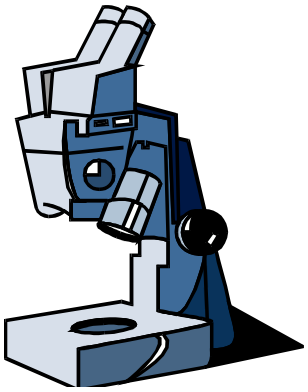
The biologist

In a biology experiment, the growth of a population is being investigated.
P is the number of items in the population and t is the time. The biologist has a set of values

t	0	1	2	3
P	0	100	500	1,200



He then searches a model (e.g. a function $P(t)$ that could match the set of values).

1) His youngest student proposes a linear function.
   His oldest student suggests $P(t) = a^t$ (where a is a constant real number).
   Another student thinks that the function is $P(t) = \frac{-500\,t}{3\,t-8}$
   What could the biologist answer to each of them?

2) The biologist finally chooses a quadratic function.
   Give the expression for $P(t)$ and the expected value for $t = 4$.

3) Could you suggest another model?

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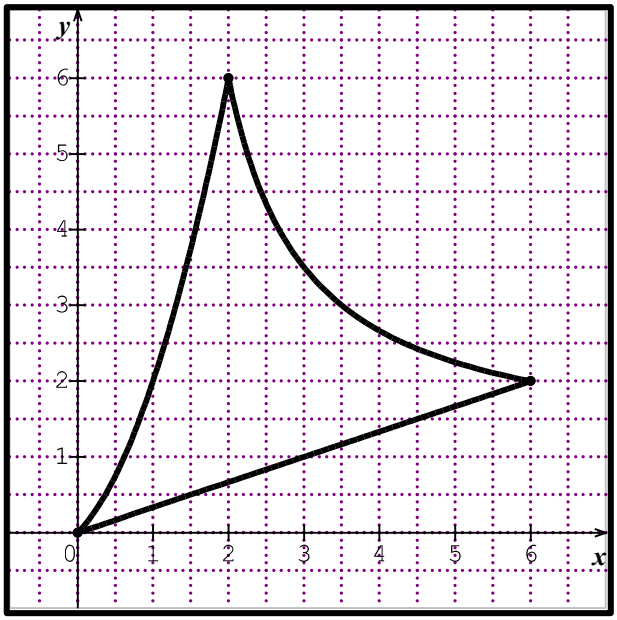
The sailboat showroom

A firm which builds sailboats needs to refurbish its showroom. The logo will be painted on the wall near the front door.
The designer has drawn the logo to scale (1 unit for 0.5 m):



It is a square in which we can see two curves and a straight line that are supposed to represent a sail.
The equations of the two curves are $y = x^2 + x$ and $y = 1 + \frac{5}{x-1}$.
To paint the sail, a silver material will be used, while the remaining part of the square will be painted blue. The painter's bill is £10 per m² for the blue part and £15 per m² for the silver sail. What is the cost for the whole logo?

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Sujet 23

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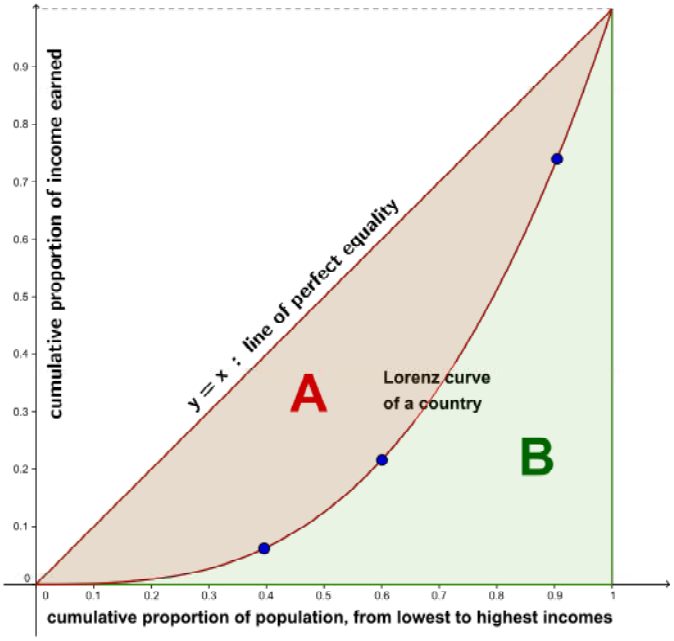
What about income distribution in a country?

We can use **Lorenz curves** to visualize how the income is distributed in a country.
For example, in this country, one of the blue dots indicates that 40% of the poorest part of the population share only 6% of the total country income.



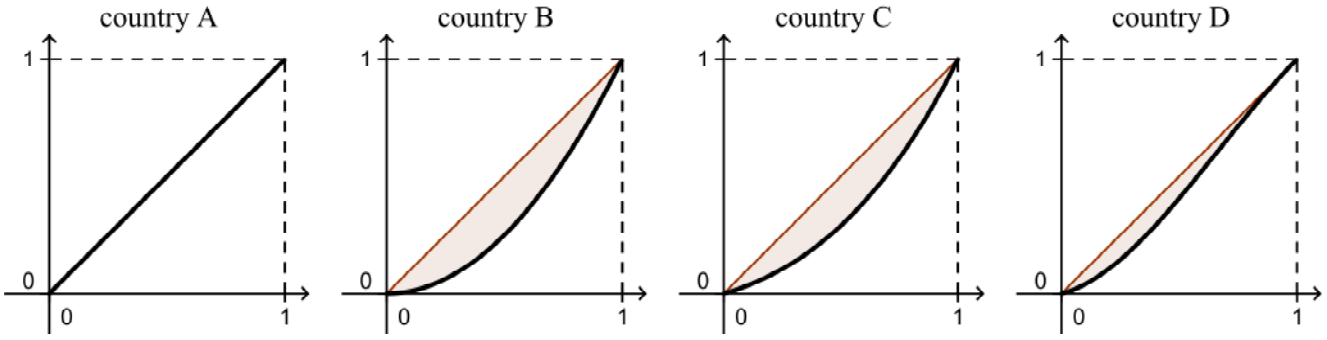
Question 1: What do the other two dots mean?

The closer the curve is to the line of perfect equality, the more equal the share of the income.

If we want to measure how equal income distribution is in a country, we can calculate its **Gini coefficient**. This number is equal to the area marked A divided by the sum of the areas marked A and B, that is $Gini = \frac{A}{A+B}$.

Question 2: Explain why we also have $Gini = 2 \times A$.

Now have a look at the Lorenz curves of a few (imaginary) countries:



$a(x) = x$ $\quad b(x) = x^2$ $\quad c(x) = e^x - (e-2)x - 1$ $\quad d(x) = -\frac{3}{4}x^3 + \frac{3}{2}x^2 + \frac{1}{4}x$

Question 3: Find out the Gini coefficients of these countries, and order them according to income distribution.

Question 4: In which country do you think the situation is the best? Why?

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Sujet 24

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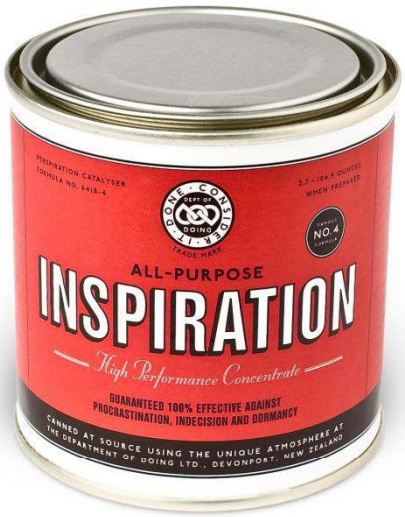

A cylindrical can is made up of 25 square inches of material. What dimension to the nearest hundredth would maximize the volume of this can?

Hint: *you can show that the volume can be expressed in terms of its radius:* $v(R) = 12.5\,R - \pi R^3$

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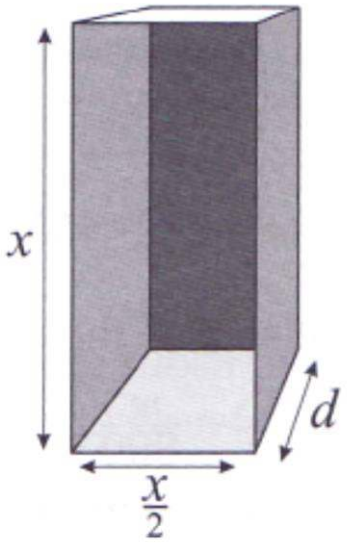
The bookcase

Ayesha is building a closed-back bookcase. She uses a total of 72 m² of wood (not including shelving) to build a bookcase that is x meters high, $\frac{x}{2}$ meters wide and d meters deep, as shown. She would like to find the value of x required to achieve the maximum volume, and state what the maximum volume is.



1) Show that the full capacity of the bookcase is given by: $V(x)=12x-\frac{x^3}{12}$.

2) Maximum
   a. State the range of values of x for which V is increasing or decreasing.
   b. Find the value of x for which V is stationary.
   c. Show that this is a maximum point and hence calculate the maximum V_{max}.

3) Curve
   a. Show that $V(x)$ can be written as $V(x)=\frac{x}{12}(12-x)(12+x)$.
   b. What can this expression can be used for?

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Sujet 31

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The weather

The probability of a fine day is $\frac{3}{7}$ and the probability of a wet day is $\frac{4}{7}$.

If it's a fine day:

the probability Joe rides his bike to work is $\frac{7}{10}$,

the probability Joe drives to work is $\frac{2}{10}$,

otherwise Joe takes the train.

If it's a wet day:

the probability Joe rides his bike to work is $\frac{1}{9}$,

the probability Joe drives to work is $\frac{5}{9}$,

otherwise Joe takes the train.

1) For any given day, what is the probability Joe takes the train to work?

2) If Joe works 315 days in a year, how many days is he likely to drive to work?