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Epreuve de D.N.L. Mathématiques – Anglais session 2023

You have to talk for ten minutes about this subject. Which mathematical notion(s) do you recognise? The questions may help you, but answering all of them is not compulsory: you can simply explain a way to solve an exercise, even if you can't find the solution.

Subject 10: Australia on fire O

In November 2019, more than three-quarters of the Australian continent experienced the worst fire weather conditions ever.

https://www.koaa.com/weather/weather-science/australian-wildfires-scorch-the-equivalent-of-more-than-23-of-colorados-land

1 acre ≈ 4,047 m²

Experts warned this could have a devastating impact on tourism.

The Australian Ministry of tourism estimated that 40 % of the foreign tourists who already had a flight ticket to Australia planned to cancel their reservation.
The Ministry also estimated that 30 % of the tourists who said they would cancel their reservation would finally come and visit Australia, and that 90 % of the tourists who didn't plan to cancel would finally come.
Imagine that a tourist who already had a flight ticket to Australia was selected at random.
Let A be the event "the tourist planned to cancel his reservation" and B the event "the tourist came to Australia".

1) Is it true that the probability that the tourist ended up coming is less than $\frac{2}{3}$?
2) Are the events A and B independent?
3) Assuming that the tourist didn't come to Australia after all, what is the probability that he or she had planned to cancel?
4) A random sample of 20 tourists who already had a flight ticket to Australia is selected.
   Compute the probability that exactly 8 of them had planned to cancel.

If you have time

If a commercial discount had been offered to make sure 72% of the tourists came to Australia in spite of the fires, what percentage of tourists would have planned to cancel their reservation ?

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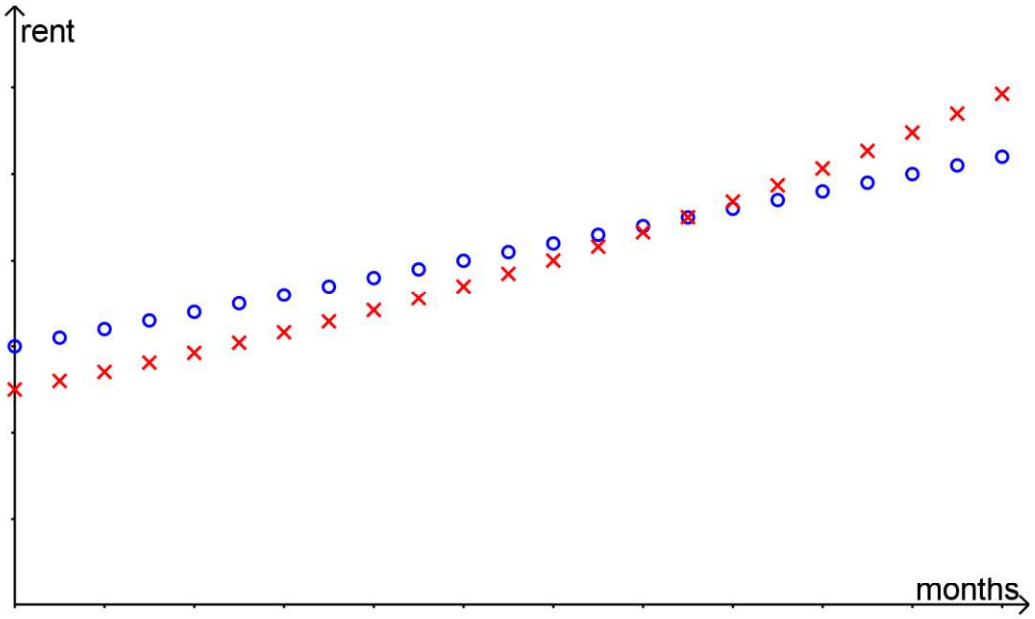
Subject 11: Studying abroad XT

Carl is a young student. He recently passed his exams and will enter university next year. He decided to study abroad. Therefore, he will need to rent an apartment. He is interested in two apartments. The cost of each rental is:

- Apartment A: $300 for the first month and a $10 increase each month thereafter
- Apartment B: $250 for the first month and a 4% increase each month thereafter.

1. Carl plotted the cost of each apartment on the graph below.



Match each scatter graph* (crosses × or circles ○) with the corresponding apartment.

Use the scatter graph, any formula you want or your calculator to answer the next questions:

2. How much would Carl pay on the second month for each apartment? How much would he pay on the last month of the first year?

3. Which apartment is the least expensive if Carl plans to stay one year? Two years?

4. Carl will not be able to spend more than $500 a month for this apartment. How many months can he stay if he chooses apartment A? Apartment B?

If you have time

What would the average rent be for each apartment if Carl decided to stay two years?

Vocabulary: *Scatter graph : nuage de points

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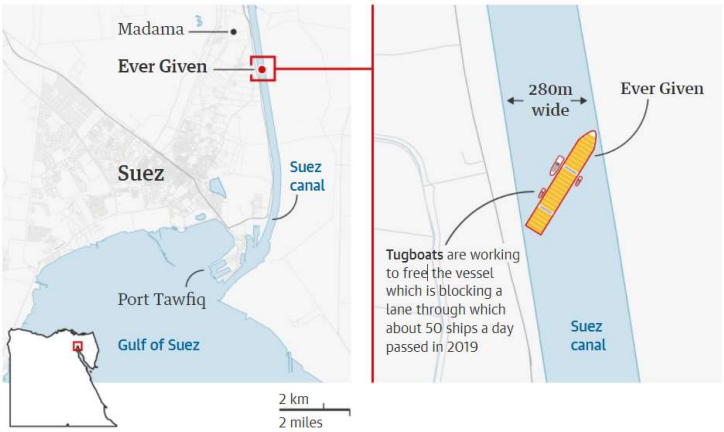
Subject 25: Suez Canal traffic jam O

More than 100 ships got stuck at the Suez canal as tugboats[1] tried to free a container ship blocking one of the world's key trade arteries. A 400-metre-long ship called "Ever Given" became stuck on Tuesday morning. The Suez Canal Authority (SCA) said the ship had lost the ability to steer because of a dust storm. Traffic stopped on both sides of the lane through which about 50 ships a day passed in 2019. Old sections of the canal have been reopened in an effort to ease congestion.



The guardian – Wednesday, the 24th of March 2021[2]

1. Consider that 100 ships are stuck at the Suez canal and 50 new ships are stopped each day, how many ships are still waiting 2 days after the accident? 10 days after the accident?

2. To avoid such a mess, the SCA opened old sections of the canal and we consider that 20% of the waiting ships have been able to cross the canal since the first day.
   a. Show that at the end of the first day after the accident, 130 ships are still waiting to cross the canal.
   b. Work out the number of waiting ships two days after the accident.

3. Let a_n be the number of waiting ships n days after the accident.
   a. Explain the relationship $a_{n+1} = 0.8 \times a_n + 50$.
   b. Using a proof by induction, show that $a_n = 250 - 150 \times (0.8)^n$.
   c. How many ships are still stuck 10 days after the accident?

[1] Tugboat : remorqueur

[2] https://www.theguardian.com/world/2021/mar/24/suez-canal-traffic-jam-builds-as-work-to-move-megaship-continues

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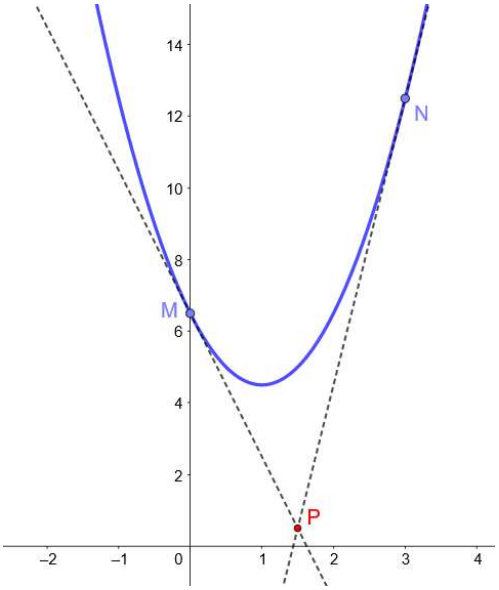
Subject 39: On the road again O

Source: https://www.thetimes.co.uk/article/news-in-pictures-wednesday-september5-2018

During a stage of the Tour of Britain, the riders are on a road that can be modelled by the function $f(x) = 2x^2 - 4x + 6.5$.
x and $f(x)$ are measured in metres.
The x -axis represents a river.
M is the point with abscissa 0 and N is the point with abscissa 3.



A photographer would like to take pictures of the riders in that curve between M and N without falling into the water.

We will assume that the position P of the photographer is the intersection point between the tangent lines to the curve at points M and N as shown on the graph.

How far is the photographer from the river ?

Hint: The y-intercept of the tangent at N is -11.5

If you have time
What is the shortest distance between the road and the river ?

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Subject 41: the delivery man O

https://vistapointe.net/delivery-man.html

A delivery man drives each day the same 160 km round trip*.
Each hour, his fuel consumption in liters, depends on the average speed (s) of the truck and is given by $f(s) = \frac{s^2}{200}$ where s is expressed in $km.h^{-1}$.
One liter of diesel costs 0.90 €.
The delivery man is paid 15 € per hour.

1) Check that the overall cost (salary plus fuel) of a round trip with an average speed of 80 $km.h^{-1}$ is equal to 87.60 euros.

2) Since his wages are quite low, the delivery man thinks that the faster he drives, the cheaper it is for his boss… and the better it is also for his own spare time. Do you agree with him? Give an example.

Let's assume that the overall cost (c) is given by: $c(s) = 0.72\ s + \frac{2400}{s}$.
with s ranging from 10 km.h^{-1} to 110 km.h^{-1}.

3) Find the average speed which minimizes the overall cost (round it up to the nearest whole number).

4) What's the minimum cost the boss has to pay for this daily round trip?

If you have time: Try to explain how to get the formula $c(s) = 0.72\ s + \frac{2400}{s}$.

* one way and return

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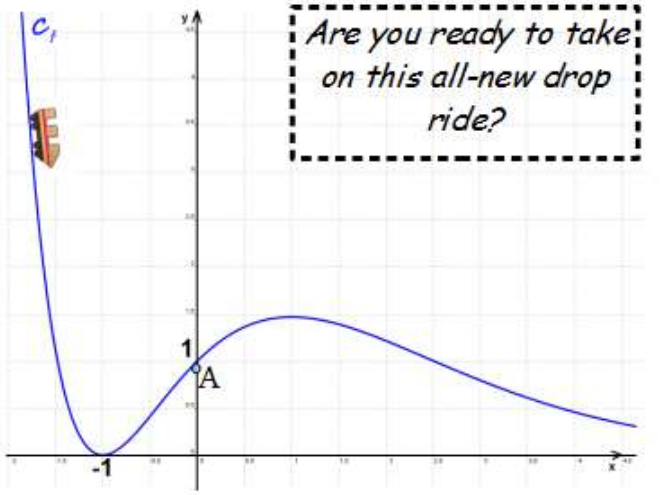
Subject 45: Six flags O

Source: http://2.bp.blogspot.com/-gfSHYQzzr6g/U8wf1gbHSeI/AAAAAAAAgIM/iV9U_fvZbWQ/s1600/Zumanjaro+1.jpg

Six Flags Great Adventure in New Jersey, USA, introduces Zumanjaro: Drop of Doom, a brand new record-breaking drop ride featuring breathtaking views, impressive heights, astonishing speeds, stomach-tightening drops, and an adrenaline rush like no other. It is the tallest and fastest drop ride in the world, lifting riders up 415 feet in the air and rocketing back down at 90 miles per hour.



The trajectory of this amazing roller-coaster is assimilated to the curve C_f of a function defined on $\mathbb{R}$ by $f(x) = (ax^2 + bx + c)e^{-x}$ where a, b and c are numbers.

The unit used on the graph and in the equation is the decameter.

The incomplete monotony table is given:

x	$-\infty$		-1		$+\infty$
$f'(x)$		$-$	0		
$f(x)$	$\searrow$			$\nearrow$	$\searrow$

1.a) Use the graph, to determine a , b and c.
b) Complete the monotony table and justify your answers.

2. In this question, you have to study the relative position between the curve C_f and its tangent T at point A.
Justify that to solve the problem, it is necessary to determ the sign of $(x + 1)g(x)$ where g is the function defined on $\mathbb{R}$ by $g(x) = (x + 1)e^{-x} - 1$.

If you have time:
Study the sign of $g(x)$ and conclude
or
Do you like going to fun fairs? Why or why not?