Sections Européennes - Session 2025

Sujet n°1

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STATISTICS

Two restaurants in the city center, "Gourmet Delight" and "Tasty Bites", have been competing for customers for the past year. The city's food critic wants to compare these restaurants based on customer ratings (marked from 1, the worst, to 10, the best) and other relevant data.

Gourmet Delight:

- Customer ratings (out of 10) for 20 customers:
 7, 8, 9, 6, 8, 7, 9, 8, 7, 8, 9, 7, 8, 6, 8, 9, 7, 8, 9, 8
- Average meal price: €30
- Number of dishes on the menu: 25
- Seating capacity: 60

Tasty Bites:

- Customer ratings (out of 10) for 20 customers:
 6, 7, 8, 5, 7, 6, 8, 7, 6, 7, 8, 6, 7, 5, 7, 8, 6, 7, 8, 7
- Average meal price: €30
- Number of dishes on the menu: 30
- Seating capacity: 70
- a) Using your knowledge about Statistics, compare both data.
- **b)** You are tasked with advising these restaurants on how to stand out from their competitor. What strategies would you suggest? How do your statistical findings support these recommendations?

Sujet n°2

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Quadratic functions



FIGURE 1 – Dunnotar Castle and Royal Deeside, Scotland

The commissioner of Highland Roads and Bridges wants to build a new road between three cities of Scotland: Inverness, Royal Deeside and Moray. This new road should have the shape of a parabola.

The commissioner sketches the situation with a graph in a rectangular coordinate system (the unit is $1\ km$ on each axis). The cities have the following coordinates in this grid:

- Inverness I(0;8)
- Royal Deeside D(2;3)
- Moray M(4;6).
- 1. Can you find the equation of the parabola?

Hint: You search for a quadratic function. Three simultaneous equations will help you to do so.

2. The river Dee runs close to the city of Royal Deeside. It is represented by the x-axis on the graph of the commissioner. The road must be, at least, at a distance of 1 km of the river Dee. Does the road satisfy this condition?

Sujet n°3

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Sequences



FIGURE 1 – Léon Marchand J.O. 2024

Bob Bowman is a famous swimming coach. He coached the U.S Olympic team for many years. One famous swimmer of his team was Michael Phelps, who won twenty three gold medals at the Olympics.

In 2021, B. Bowman received an email from a young French swimmer asking him for a scholarship and a place in his swimming team. B. Bowman agreed and did not regret it since this young French swimmer is Léon Marchand, who won four gold medals at 2024 Paris summer Olympics.

The trainings of Bob Bowman are known to be very demanding for the swimmers.

"It varies day by day, but in a given week, I train about 25 to 30 hours a week. I swim about 10 times a week for 2 hours, and then I have dryland or weights training five days a week for about an hour each. It's a lot." said Léon.

Usually, Léon swims 10 kms 10 times a week. For the preparation for 2024 Paris summer Olympics, Bob wanted to toughen up training. He planned to increase this distance of $400\ m$ every week in order to reach a distance of $14\ km\ 10$ times a week.

1. Consider that the first week of April 2024, Léon swam 10 kms 10 times a week. The preparation for the olympics started then. When did Léon reach the goal set by Bob?

2. From April to this week, how many kilometers did Léon swim overall?

Hint: You may use a sequence (d_n) where $d_0 = 10$ and d_n corresponds to the distance that Léon swam the n^{th} week.

Were you interested in 2024 Paris summer Olympics? Do you know some famous english or american swimmers or sportsmen?

Vocabulary:

dryland training: entraînement hors de l'eau

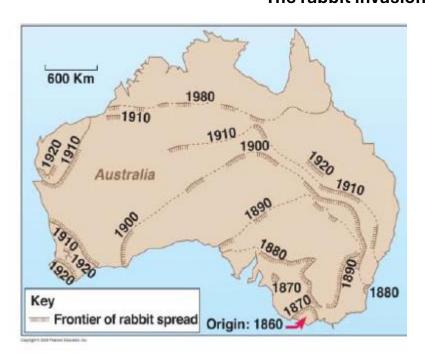
weights training: musculation

Subject n°5

SEQUENCES

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The rabbit invasion





Erosion of a gully in South Australia caused by rabbits

Source: https://en.wikipedia.org/wiki/Rabbits in Australia

Source:

http://australian-rabbit-invasion.weebly.co

m/the-inva sion.html

European rabbits arrived in Australia with the First Fleet in 1788. They were introduced for food and hunting. In 1860, 22 wild European rabbits were released in Victoria, Australia. During the first years of spread, the average monthly growth rate of the number of rabbits was 21%.

- How could you model the number of rabbits in Australia from 1860 onwards?
 Try to estimate the population of rabbits after 6 full years.
- 2) Since their introduction, the effect of rabbits on the ecology of Australia has been devastating. In 2000, after more than a century of control programs, rabbits cost Australian primary producers \$113 million in lost production and control costs. We assume that the cost steadily increased each year by \$3 million. Calculate the total amount of money lost over the period 2000-2016.
- 3) What do you think of the rabbit invasion of Australia?

Académie de TOULOUSE Sections Européennes

Session 2025

Sujet n°

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Probabilities



FIGURE 1 – Harry and Meghan (AP Photo/Matt Dunham, Pool, File)

"We intend to step back as senior members of the Royal Family and work to become financially independent".

Meghan and Harry, Duke of Sussex, Feb 19, 2021

"Following conversations with the Duke, the Queen has written confirming that in stepping away from the work of the Royal Family it is not possible to continue with the responsibilities and duties that come with a life of public service".

Buckingham Palace statement, Feb 20, 2021

In September 22, 2024, the newspaper Sunday Times made a survey on 1200 people about Meghan and Harry, Duke of Sussex. The results were as follows:

- 28% had a good opinion of Harry and Meghan.
- Among these 28%, 80% were less than thirty years old.
- 95% of the people that had a bad opinion of Harry and Meghan were more than thirty years old.

One person is chosen at random.

Consider the following events:

F : "A person has a good opinion of Harry and Meghan".

Y : "A person is less than 30 years old".

- 1. Represent this information on a tree-diagram.
- 2. Consider a person who isn't in favour of Harry and Meghan. What is the probability that he or she is more than thirty?
- 3. What is the probability that the person is less than 30?
- 4. Consider that the person is older than 30, what is the probability that this person has a good opinion of Harry and Meghan?
- 5. Are the two events *F* and *Y* independent?

Sujet n°08

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Functions

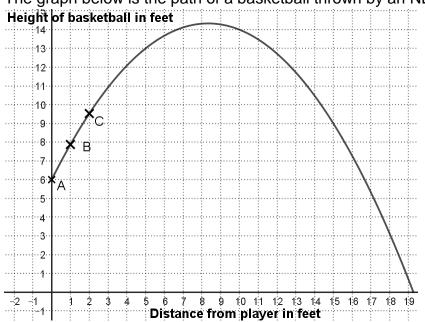
1) Warm up task:

Explain what you know about the main features of the graph of the following functions:

- a linear function
- a quadratic function
- the reciprocal function

2) Main problem:

The graph below is the path of a basketball thrown by an NBA player from the free throw line.



- 2.1) What kind of function is it?
- 2.2) Choose among the following equations the one which may correspond to this graph:

a)
$$y = -0.12x^2 + 2x + 6$$

$$b) y = 0.12x^2 - 2x + 6$$

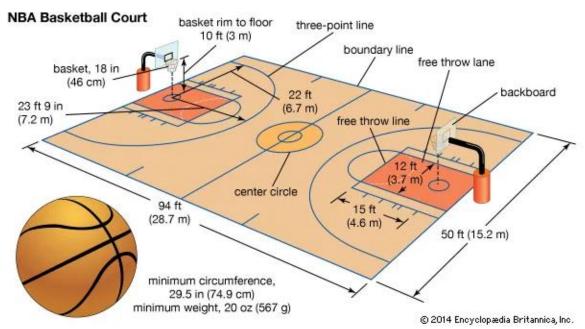
c)
$$y = -0.12x^2 + 2x - 6$$

- 2.3) The coordinates for points B and C are (1,7.88), (2,9.53) respectively. Does this new piece of information confirm or disconfirm your choice?
- 2.4) What are the key features of this graph? Determine them as precisely as you can.

3) Follow up task:

Here are the dimensions of an NBA basketball court.

Do you think the path you studied before ended up with a score?



Sujet n°08

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Functions

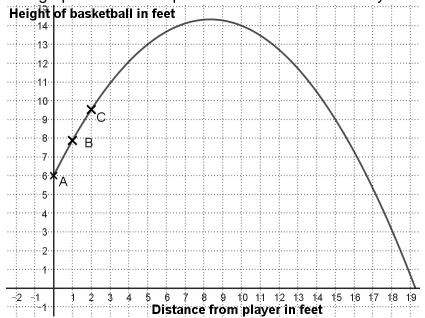
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b)
$$y = 0.12x^2 - 2x + 6$$

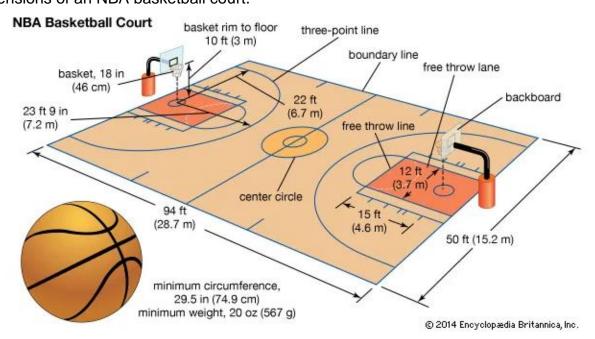
c)
$$y = -0.12x^2 + 2x - 6$$

2.3) The coordinates for points B and C are (1,7.88), (2,9.53) respectively. Does this new piece of information confirm or disconfirm your choice? 2.4) What is the highest position of the ball? Where does it hit the floor?

3) Follow up task:

Here are the dimensions of an NBA basketball court.

Do you think the path you studied before ended up with a score?



Sujet n°09

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Probabilities

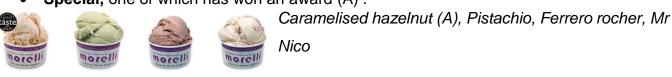
Morelli is a famous Irish ice cream brand. They have won many awards over the years, and were ranked n°6 in the article from The Guardian, "The 12 best places to buy ice cream in the UK" in June 2023. Their many flavours of frozen desserts are sorted into four categories:

Classic, four of which have won an award (A):



Double cream vanilla (A), Honeycomb, Belgian chocolate chip, Strawberry (A), Coffe (A), Rum and raisin, Mint and belgian chocolate chip, Raspberry ripple, Banana, Chocolate brownies, Bubblegum, Turkish delight, Malt tease, Coconut, Chocolate, Lemon and lime ripple, Sea salty caramel (A), Parm violet, Oreos and cream.

- Sorbet, lemon or mango (no picture here).
- **Special,** one of which has won an award (A):



Luxury:



Using this ice-cream menu, create an exercise using conditional probabilities. Explain your choices, and provide the answers to your questions.

Sujet n°09

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Probabilities

1) Warm up questions:

What are probabilities?

What is the difference between probabilities and conditional probabilities?

2) Main task:

Morelli is a famous Irish ice cream brand. They have won many awards over the years, and were ranked n°6 in the article from The Guardian, "The 12 best places to buy ice cream in the UK" in June 2023. Their many flavours of frozen desserts are sorted into four categories:

Classic, four of which have won an award (A):



Double cream vanilla (A), Honeycomb, Belgian chocolate chip, Strawberry (A), Coffe (A), Rum and raisin, Mint and belgian chocolate chip, Raspberry ripple, Banana, Chocolate brownies, Bubblegum, Turkish delight, Malt tease, Coconut, Chocolate, Lemon and lime ripple, Sea salty caramel (A), Parm violet, Oreos and cream.

- **Sorbet**, lemon or mango (no picture here).
- **Special**, one of which has won an award (A):









Caramelised hazelnut (A), Pistachio, Ferrero rocher, Mr Nico

Luxury:















Dime bar crunch, Chocolate honeycomb, Kinderelli, Minionelly two tone twist, Speculoos cookie crunch, Bueno, Vanilla & chocolate two tone twist, Mister Morelli, Creamy egg.

Using this ice-cream menu, create an exercise using conditional probabilities.

Explain your choices, and provide the answers to your questions.

Sujet n°10

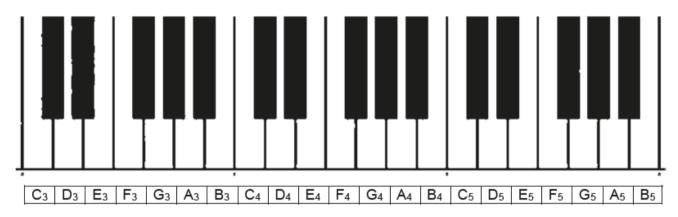
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PROBLEM SOLVING

The first part of this page is a summary that can be helpful to do the exercise.

- Music notes: A, B, C, D, E, F & G.
- The International System (SI) unit for frequency is the Hertz (Hz).

EXERCISE



In a modern 88-key standard piano, the keys begin with A0 and go up to C7.

The 49th key, the "central" A (called A4), is tuned to 440 Hertz. A jump to one higher octave doubles the frequency.

For example, the frequency of A5 is $440 \times 2 = 880 \text{Hz}$.

- 1. Work out the frequencies of A6, A3, A7 and A0.
- 2. Human ear perceives frequencies between 20 Hz to 20 000 Hz. If an instrument could play an A8, would it be heard? What about an A10?
- 3. The ratio between A4 and C4 is 1:0.595. Work out the frequency of C4.
- 4. In 2018, Adam Lopez, an Australian pop musician, held the Guinness World Record for singing a 4 435 Hz note. Is this note located between A5 and A6? Can you locate it on an octave starting with A?
- 5. Do you like music? Do you play music? Do you know any other connections between mathematics and arts?

Sujet n°11

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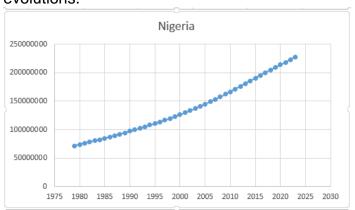
Sequences

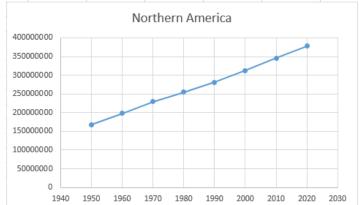
1) Warm up task:

What does the word "pattern" mean to you? What kind of mathematical patterns do you know? **2) Main problem:**

2.1) The following graphs show the evolution of the population of Nigeria and Northern America over a period of time.

Use your mathematical knowledge to identify a pattern and find a model to describe these evolutions.





2.2) Below are some of the data that were used to draw the graphs. Do they confirm or infirm your answers to question 2.1)? Can you use them to be even more precise about your models?

Northern America	1950	168009342
	1960	198252643
	1970	229339589
	1980	254502384
	1990	281282376
	2000	312499983
	2010	345386050
	2020	377734350

3) Follow up task:

Can you tell us something about the points and limitations of using mathematical models...

- ... as far as populations are concerned?
- ... generally speaking?

Nigeria	1979	71498241
Nigeria	1980	73764644
Nigeria	1981	76068116
Nigeria	1982	78378696
Nigeria	1983	80438257
Nigeria	1984	82526444
Nigeria	1985	84897972
Nigeria	1986	87235959
Nigeria	1987	89591718
Nigeria	1988	92020092
Nigeria	1989	94531021
Nigeria	1990	97120926
Nigeria	1991	99720162
Nigeria	1992	102372779
Nigeria	1993	105122075

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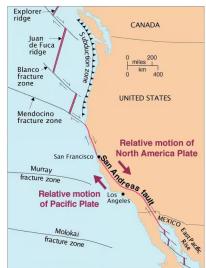
Subject n°12 FUNCTIONS

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(sources FUTURA)

The San Andreas Fault* is certainly the most famous active fault. It marks the boundary between two major tectonic plates: the Pacific Plate and the North American Plate. It stretches from northern California and runs for around 1,200 kilometres southwards, ending at Bombay Beach.



Although the San Andreas fault had been known about since 1895, it wasn't until 1906 that the general public really became aware of its existence. On 18 April, the north coast of California was shaken by a very violent earthquake. Its magnitude was estimated at 7.9. The damage was considerable, particularly in the city of San Francisco, where numerous fires broke out. Some 80% of the city was destroyed, and more than 3,000 people lost their lives.

In 1935, Charles Richter developed a scale (now known as the RICHTER SCALE) to measure the magnitude of an **earthquake**. The magnitude **M** of an earthquake on the Richter scale is related logarithmically to the energy **E** released. The formula often used is: $\mathbf{M} = \frac{2}{3} \log(\mathbf{E}) - 2.88$ where E is the

energy released (in joules) and M is the earthquake magnitude. Reminder For x > 0: $\log(x) = \frac{\ln(x)}{\ln(10)}$

Question 1: An earthquake releases 2×10^{14} J (Joules) of energy.

- (a) Compute its magnitude.
- (b) If another earthquake has a magnitude of 4.5, what is its energy release?
- (c) Compare the energy release of the two earthquakes.

Question 2: Does a large difference in magnitude correspond to a small difference in energy, or the reverse?

Question 3: Consider one earthquake with magnitude R on the Richter scale and a second earthquake with magnitude 10R. Compare the two earthquakes.

If you have time: have you ever heard of famous earthquakes?
*A fault = une faille

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Sections Européennes

Session 2025

Sujet n°14

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STATISTICS

Alison and Rob played the same 15 computer games.

• Here are the points Alison scored.

Points	28	29	30	31	33	34	37	38	39
Frequency	1	3	1	2	1	3	1	1	2

• The median number of points Rob scored is 34, the interquartile range of these points is 13 and the range of these points is 18.

Who is more consistent at scoring points, Alison or Rob? You must give reason for your answer.

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Sections Européennes

Session 2025

Sujet n°15

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PROBABILITY

- Peter throws an ordinary fair dice twice.
 Work out the probability that he gets the number 4 both times.
- 2. Emma keeps rolling this dice until she rolls a 4.

Work out the probability that Emma rolls the dice:

- a. Exactly twice
- b. More than three times.
- 3. Do you know a dice game? Or could you imagine a dice game? Introduce it and give some probabilities.

Sujet n°16

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Patterns 1, 2, 3 and 4 in a continuing sequence are shown.

Max and Lily are discussing the best way to count the number of squares in pattern 50.

Max finds 202 squares and he works out $50 \times 4 + 2$.

Lily finds the same number of squares but she works out $4 \times (50 + 2) - 6$.

- 1. Who is right? Explain your answer.
- 2. Do you know famous sequences?

 Introduce special sequences and give their *n*th term.

Subject n°17

PROBABILITIES

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Playing darts



Pamela is in a pub with two friends Kimberley and Jack. They want to play darts. Her friend Kimberley challenges her saying:

"Pamela, for sure, you're a better player than us so, in order to enhance fairness, would you agree to play three games with Jack and I as alternate opponents? If you win two games in a row*, we'll buy you dinner, but if you lose, you'll pay fish and chips for everyone."

Pamela answers: "Whom do I play first, you or Jack?"

"You may have your choice", answers Kimberley, her eyes twinkling.

Pamela knows that Jack plays a stronger game than Kimberley. In fact, her probability of success against Jack is equal to $\frac{3}{5}$ whereas her probability of winning against Kimberley is $\frac{4}{5}$.

- 1) Sketch the situation with two trees:
 - * Tree 1: she first plays Kimberley, then Jack, then Kimberley again.
 - * Tree 2 : she first plays Jack, then Kimberley, then Jack again.
- 2) Can Pamela maximize her chance by choosing her first opponent?
- 3) Would the result be any different if, instead of having to win two games in a row, Pamela was declared the winner by winning two games (in a row or not)?
- 4) Have you ever played darts? Do you know the origin of this game?

*In a row : d'affilée

Subject n°18

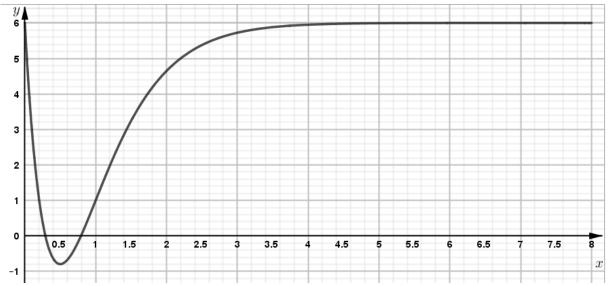
FUNCTIONS

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About the Thames depth

Near Tilbury, the depth of the Thames in the estuary is about 8 metres. We assume that on a winter day in the Thames estuary the water temperature (in degrees Celsius) expressed according to the depth x (in metres) can be modelled by the following function: $f(x) = 6 - 275xe^{-2x-2}$

1) Using the formula above, justify all the aspects of the graph below representing the function f (variations, maximum, minimum, depths for which the temperature is below 0°).



- 2) Does a temperature under 0°C mean that the Thames will be frozen?
- 3) According to BBC News Magazine between 1309 and 1814, the Thames froze at least 23 times and on five of these occasions the ice was thick enough to hold a fun fair. Do you think that such a thing could be repeated today?



Anonymous painting of the Frost Fairs on the frozen Thames, winter 1620-21 National Gallery

Sections Européennes

Session 2025

Sujet n°19

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Functions

In a sports training program, an athlete's performance (measured in points per game) improves over time due to consistent training.

Initially, the athlete scores 10 points per game.

The performance increases by 5% per week.

- 1) Find a model of the athlete's performance over time, and determine the athlete's performance after 8 weeks.
- 2) To be selected for the Commonwealth games, the athlete needs to score at least 30 points per game; how many weeks are needed to achieve this performance?

Sujet n°20

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Probability

A company is conducting a market survey to understand the buying behavior of its customers. The survey reveals the following:

- 60% of the customers are interested in purchasing a new product.
- 40% of the customers are willing to pay a premium price for high-quality products
- 25% of the customers are both interested in purchasing the new product and willing to pay a premium price for high-quality products.
- A customer is chosen randomly.

Questions:

- 1. What is the probability that a customer is willing to pay a premium price given that they are interested in purchasing the new product?
- 2. What is the probability that a customer is interested in purchasing the new product given that they are willing to pay a premium price?
- 3. Are the events "The customer is interested in the new product" and "The customer is willing to pay a premium price" independent?

Sections Européennes - Session 2025

Sujet n°22

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PROBABILITY

In today's digital age, online shopping platforms have become increasingly popular, allowing customers to share their experiences through reviews. These reviews can significantly influence potential buyers' decisions. However, the reliability of these reviews is often questioned.

Consider an online shopping platform that allows customers to leave reviews for products they have purchased. The platform is investigating the reliability of these reviews. Let A be the event "A review is authentic" and B be the event "A review is positive".

A review is selected at random.

A statistic survey provides following information:

- 80% of reviews on the platform are authentic.
- Among authentic reviews, 70% are positive.
- Among fake reviews, 90% are positive.
- 1. The platform claims that "Over 85% of our positive reviews are authentic"

 Assess the accuracy of this statement based on your mathematical calculations.
- 2. Discuss what insights can be drawn about the relationship between review authenticity and positivity. Base your arguments on the comparison of the probability of a review being positive given that it is authentic, and the probability of a review being positive given that it is not authentic.

Académie de Toulouse - sections européennes - session 2025 Subject n°23

PROBABILITY

A bag of lollipops contains two fruit lollipops, one mint lollipop and two caramel lollipops.

Mark picks up successively two lollipops that he eats.

- 1. Model the situation and explain what can happen and what cannot happen.
- 2. Mark eats a fruit lollipop as a second lollipop.
 What is the probability that his first pick was a caramel one?
- 3. Instead of eating it, Mark only picks up one lollipop and puts it back it 5 times.

His friend tells him that his chance to pick at least once the mint one is more than 95%.

What do you think?

Sections Européennes - Session 2025

Sujet n°24

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FUNCTIONS

A small business produces and sells handmade wooden toys. The owner wants to maximize the daily profit. The profit function P(x) is a quadratic function that depends on the number of toys x produced and sold per day.

The data stored in the accounting system of this business provides following information:

- When 10 toys are produced and sold, the daily profit is €200.
- The fixed costs are €150. Hence, when 0 toys are produced, the daily profit is €150.
- The maximum possible daily production is 40 toys.
- When the maximum number of toys is produced, the profit becomes negative due to increased labor costs and decreased quality, resulting in a loss of €100.

The owner of this business aims to achieve a daily profit of €350.

Based on your analysis of the profit function, what is your opinion on the realism of this goal? Explain your reasoning, considering both mathematical and practical business aspects.

Académie de Toulouse - sections européennes - session 2025

Subject n° 25

STATISTICS

Question 1

Over a 3-week period, Molly kept a record of how many minutes her school bus was either early or late : She used « + » for late, and « – »for early.

+2	-1	0	+5	-4	-7	0	-8	0	+4	-4	-3	+14	+2	0

The bus company claims that on an average day they are on time. What is your opinion?

Question 2

Mr Jones posted 88 Christmas cards on Monday.

His friends received them over the week: 40 on Tuesday, 28 on Wednesday, 9 on Thursday, 6 on Friday, and the remainder on Saturday.

The post claims that « at most 15% of the posts arrive after 2 days ».

What is your opinion in the light of the data?

Geometry, scales

In architecture, pentagons are rarely used but there are two examples: one in the United States (Virginia), the other one in China (Shangaï) which is an exact replica.

<u>Pentagon (Virginia, USA)</u> - Ministry of Defense Headquarters:



Pentagon (Shangaï, China) - Shopping center:



Find two mathematical questions related to this particular shape and photos, then answers.

Give the main steps to solve these questions.

<u>Hint</u>: For the US and China, each side is 281 m long. One FIFA football pitch has an area of 7,140 m².

Probabilities

You are playing cards (from a 32 cards set) and you have one card left to draw*.

You can win either by drawing an extra Ace or by making a run* of three cards (regardless of suit*).



1/ What is the probability to draw an Ace?2/ Find another possible question and answer it.

^{*} to draw a card : tirer une carte

^{*}a run: une suite de 3 cartes (ex: 7-8-9 ou 10 - Valet - Dame);

^{*}regardless of suit : peu importe la couleur.