

Session 2026

Sujet n°1

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Statistics

From 2001 to 2024, the UK lost 23.9 kha of tree cover from fires and 561 kha from all other drivers of loss. The year with the largest tree cover loss due to fires during this period was 2009 with 2.76 kha lost to fires – 7.3% of all tree cover loss for that year.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Tree cover loss (kha)	30.4	24.0	28.8	23.0	26.3	28.4	22.8	26.2	34.2	21.6	22.8
Tree cover loss from fire (ha)	514	132	293	320	112	216	120	119	114	53	101

- According to the FAO, the rate of reforestation in the UK was 15.0 kha per year between 2015 and 2020.
- According to the FAO, there were 22.9 k people employed in the UK Forestry sector in 2015 of which 24% were female. (FAO: Food and Agricultural Organization of the United Nations)
- Surface of the UK: 241,930 km² (land area)

Source: *Globalforestwatch.org*

1. Given that 1 ha = 10⁴ m², what percentage of land area has disappeared in the UK between 2014 and 2024?
2. TRUE or FALSE? "Fires were responsible for more than 7% of tree cover loss in the UK between 2014 and 2024." Justify.
3. What is the average tree cover loss per year in the UK between 2015 and 2020? Compare it to the rate of reforestation between 2015 and 2020.
- 4.a) Explain why the median of tree cover loss from fire between 2014 and 2024 is 120 ha. Compute the lower and upper quartiles.
 - b) These are the statistics for tree cover loss from fire between 2014 and 2024 in Romania:
Min = 14 ha, Q₁ = 30 ha, Med = 58 ha, Q₃ = 167 ha, Max = 325 ha, Surface: 238,391 km² (land area)
Use boxplots to compare these to the statistics of the UK. Can you explain the differences?
5. How many women were employed in the UK Forestry sector in 2015? In your opinion, why is this number so low, compared to the number of men?

Vocabulary: drivers of = causes

Note: 1 kha = 10³ ha.

Session 2026

Sujet n°2

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Percentage, proportion

Léa runs a restaurant in Nantes. She comes back from a trip in Leeds (England) with the recipe of Yorkshire pudding:

Ingredients for 8 large puddings:

• 5 ounce plain flour	• 4 eggs
• 7 fl oz milk	• sunflower oil, for cooking.

Heat the oven to 450° F.

Drizzle a little sunflower oil evenly into two 4-hole Yorkshire pudding tins and place in the oven to heat through.

To make the batter, tip 5 ounce plain flour into a bowl and beat in 4 eggs until smooth. Gradually add 7 fl oz milk and carry on beating until the mix is completely lump free. Season with salt and pepper.

Pour the batter into a jug, then remove the hot tins from the oven. Carefully and evenly pour the batter into the holes. As soon as the batter is poured in, it will set and start to cook giving you crisp well-risen puds.

Place the tins back in the oven and leave undisturbed for 20-25 mins until the puddings have puffed up and browned. Serve immediately.

(Source: adapted from Vocabulaire Décembre 2022)

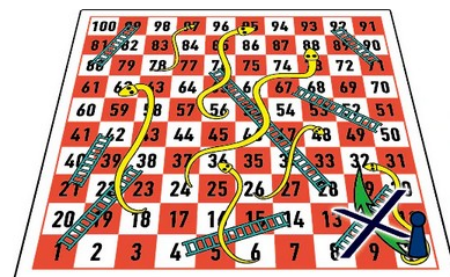
1. Do you know any traditional British dish?
2. Back home, Léa decides to cook 180 puddings for her special Christmas menu. Knowing that 1 ounce $\approx$ 28.3 g and 1 fl oz $\approx$ 28.4 ml, how many eggs, litres of milk and kilogrammes of flour does she need? (round your results to 1 decimal place if needed).
3. Léa remembers that she had learned at school that: $^{\circ}\text{F} = ^{\circ}\text{C} \times 1.8 + 32$. What will be the temperature of her oven in $^{\circ}\text{C}$, to bake the Yorkshire puddings?
4. A dozen of eggs cost 3 €, 1kg of flour 0.55 € and 1L of milk 0.8 €. What will be the cost price of one pudding in Léa's restaurant? (rounded to 0.01€)
5. Léa adds up the cost of labour and the fixed costs. At the end, the price of a pudding excluding taxes is 4.10 €. In France, V.A.T. rate is 10% in restaurants. What will be the price of a pudding on the menu?
6. The pudding represents 14% of the price of the full Christmas menu. What is the price of the full Christmas menu? (rounded to the nearest euro).
7. After Christmas, Léa sells the left over puddings 3.5 € each. What percentage of discount does she apply?

Sujet n°40
Probabilities

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Question :

Have you ever played this game (shown opposite) or any board games?



Imagine The Foggy Forest Race. Players move through a forest where each step can trigger a hidden event. Here is a simplified version.

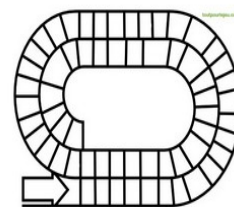
Rules :

A token starts on square 1. Each turn, the player rolls a fair 6-sided die:

- If the die shows 1, 2, or 3, the token moves +1 square.
- If the die shows 4 or 5, the token moves +2 squares.
- If the die shows 6, the player enters a Fog Zone:
 - With probability 0.7, the fog pushes the token back 1 square.
 - With probability 0.3, a magical creature teleports the token forward 3 squares

Question :Based on the rules of the game, do you think a player is more likely to advance quickly or be slowed down? Explain your reasoning before doing any calculations.

To model the exercise, it is suggested to draw a board , as shown opposite.



Let X , a random variable, be the total number of squares the token advances (positive or negative) during a turn.

1) Consider the event A: "Move +1".

Assuming that $p(A) = \frac{1}{2}$, compute the probabilities of the two other main cases ;

B: "Move +2",

C: "Enter Fog Zone"

2. Let F be the event "Fog pushes the token back", and T the event "Fog teleports forward".

Compute:

a) $P(F)$

b) $P(T)$

3. Compute the probability distribution of X , in a table.

4. a) Compute the expected value $E(X)$.

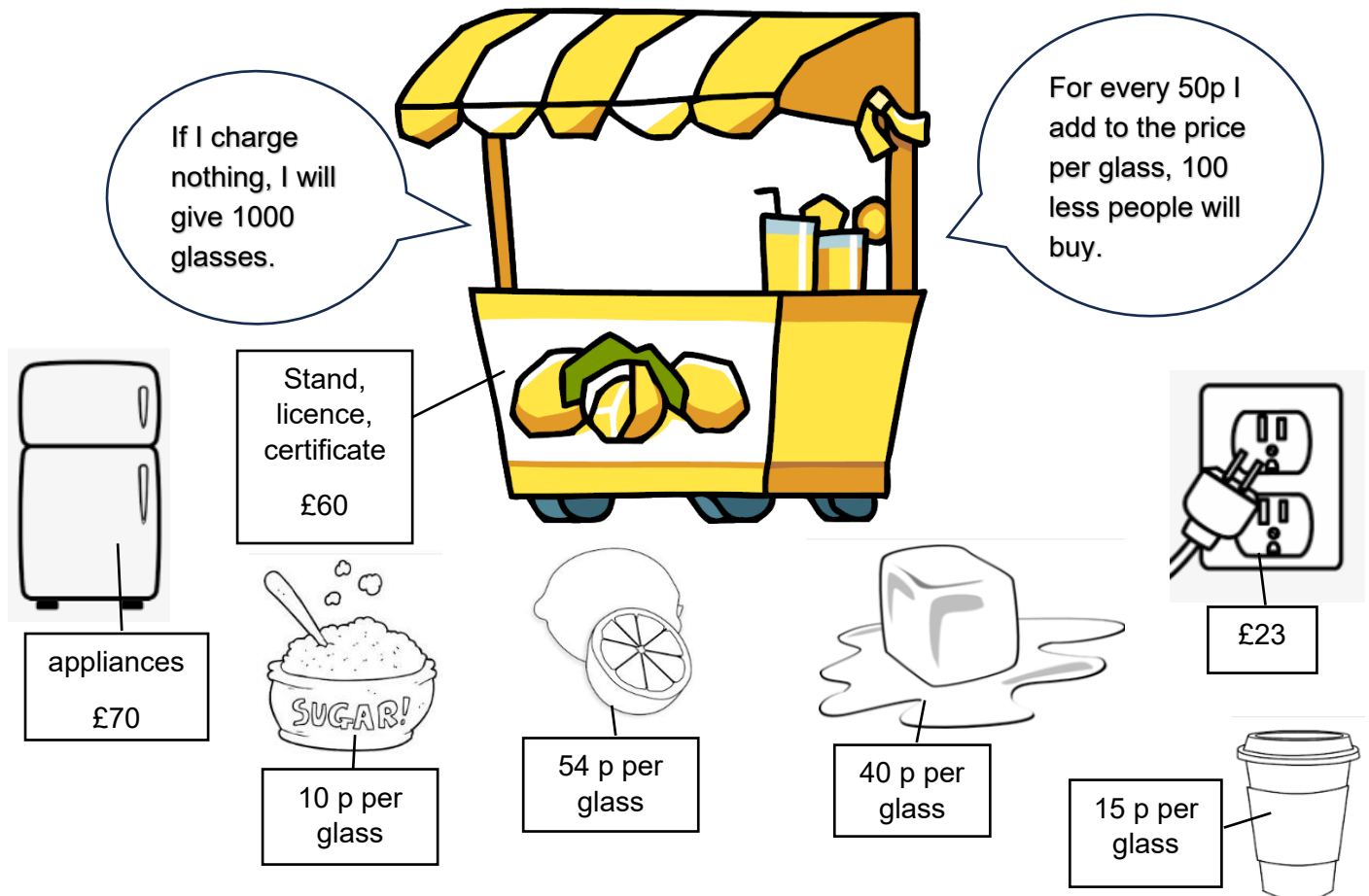
b) Determine the expected number of squares gained after 10 turns.

Sujet n°41

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Functions

Billy wants to make money during the summer holidays by selling lemonade. Since she has only two months, she wants to set the best price to maximise her earnings. First she has carried out a survey that shows how many glasses she can expect to sell, depending on their price. Then she has also gathered information about her expected costs. Here is what she has found out:



How much do you think she should charge for one glass of lemonade?

Hint: three functions could help you answer the question:

- the revenue function is the function that gives the money you can collect through sales in terms of the number of glasses you sell,
- the cost function is the function that gives your costs in terms of the number of glasses you make,
- the profit function is the function that gives the money you earn in terms of the number of glasses you sell (when the costs have already been taken away).

Sujet n°42

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Probabilities

Question :

During the COVID-19 pandemic, some people got really suspicious about vaccines.

For instance, on May 6, 2021, Fox News host Tucker Carlson suggested to his 3.3 million viewers that more than 3,000 people had died from the COVID-19 vaccines, and even said: "The actual number is almost certainly higher than that, perhaps vastly higher than that".

This was a blatant misuse¹ of data, but people could lack the mathematical knowledge to understand what they were witnessing.

For example, it is true that in hospitals, by late 2020, there were more vaccinated people than unvaccinated people.

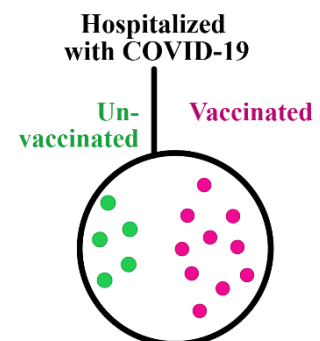
- 1) Look at this first diagram, from Wikipedia (by Marc Rumilly):

Let us choose a person at random in a hospital.

Which events can you define?

Which probabilities can you calculate?

Would you agree with the sceptics who concluded that vaccines were at best inefficient, at worst dangerous?



That first diagram tells only part of the story though.

- 2) Look at this second diagram (by the same author):

What is the same?

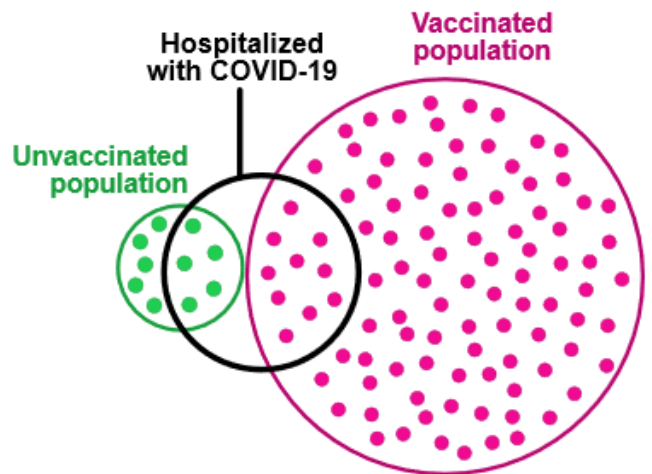
What is different?

Let us choose a person at random among all the people represented in the diagram.

Go through the same questions as for question 1).

- 3) You should have concluded that the sceptics were wrong to oppose vaccines.

This misuse of probabilities is called "the base rate fallacy". Can you explain this phrase?



Additional question:

Leonard Mlodinow is an American physicist and mathematician. In 1989 he took an HIV test and got a positive result.

The probability that this test would produce a positive result when the blood was not infected was 1 in 1000. Mlodinow's doctor interpreted this as the probability that his blood was not infected, and told him he most certainly had HIV.

Can you explain the mistake of Mlodinow's doctor?

Additional data you could use are: in 1989 in the USA an estimated 0.014% of the population had contracted HIV. The test was able to detect the virus in 98.5% of the contaminated blood samples.

¹:blatant misuse: détournement manifeste.

Sujet n°43

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FUNCTIONS**Australia, 1995 :**

In Australia, nearly 90 per cent of our petroleum wealth is found offshore. The search is difficult, extremely expensive, and often fruitless - but critical to the nation's economic future.

Locating an oil and gas "trap" - as it is known - and extracting the oil and gas is difficult enough on land. But offshore, in deep and often stormy waters, it becomes an awesome undertaking.



Source: Department of Resources (Australia), Energy & Tourism (1995)

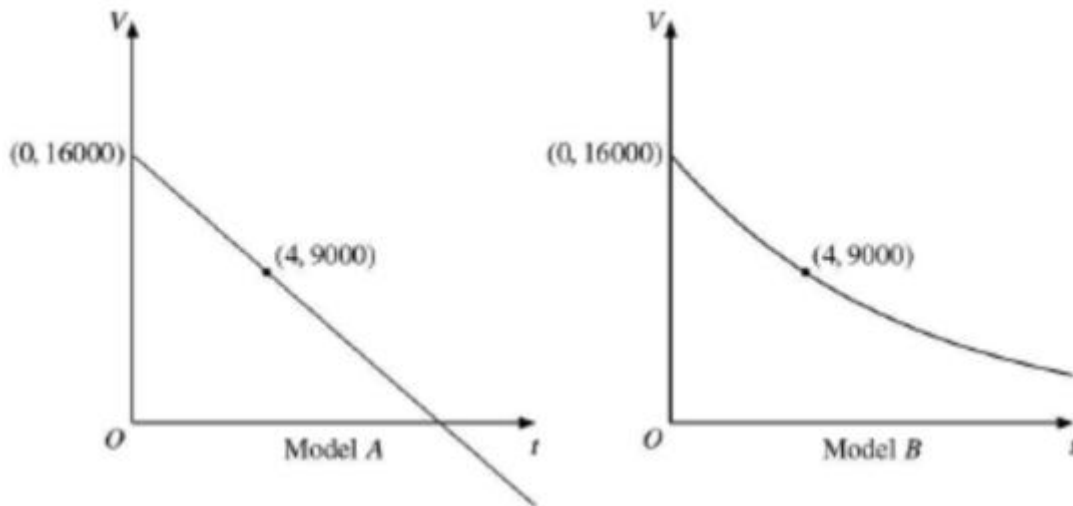
The company decides to use a model to estimate the daily volume of oil that will be extracted. The model includes the following assumptions:

- The initial daily volume of oil extracted from the oil field will be 16 000 barrels.
- The daily volume of oil that will be extracted exactly 4 years after the start of drilling will be 9000 barrels.
- The daily volume of oil extracted will decrease over time.

The diagram below shows the graphs of two possible models.

Sujet n°43

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- 1) Use model A to estimate the daily volume of oil that will be extracted exactly 3 years after the start of drilling.
- 2) Write down a limitation of using model A.
- 3) Using an exponential model and the information given in the question, find a possible equation for model B.
- 4) Using your answer to 3) estimate the daily volume of oil that will be extracted exactly 3 years after the start of drilling.

Australia, 2025 :

What do you think about oil extracting nowadays ?

Sujet n°44

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PROBABILITY

Aubrey Drake Graham (born October 24, 1986) is a Canadian rapper, singer, and actor.

- 1) Ellen is buying tickets to a Drake concert. On ticket master she has to choose two different things, whether she wants floor seating or arena seating, and whether she wants to be to the left, right, or centre.

Seat style	Location choices
Floor seating (4000 seats)	Left (2500 seats including 1000 on the floor)
Arena Seating (6000 seats)	Centre (5000 seats including 2000 on the floor)
	Right (2500 seats including 1000 on the floor)

How many possible sections of seating can Ellen choose from?

Knowing that she is the first one to buy her ticket and chooses her seat randomly, what is the probability she buys a seat at the centre of the arena?

- 2) Drake has a concert in Limerick tonight and he can't decide what to wear! He only packed 4 shirts to Ireland: His Navy shirt, his beige shirt, his Jaden Smith shirt, and his Grey Hot Line Bling turtle neck. He also only packed 3 pairs of shoes: Gold Air Jordans, Black Nike Airs, and his Timberlands. He likes all combinations equally.
- How many shirt/shoe combinations are possible?
 - Use a tree diagram to show all the outcomes.
 - What is the probability of Drake choosing his beige shirt and his Timberlands?
 - What is the probability he will wear any shirt with his gold Air Jordans?"
- 3) Do you like art (visual art, music, acting, dance, movies...) ? Give examples and explain.

Sujet n°45

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SEQUENCES

Employees of a real estate agency must choose between two types of payment for their monthly salary :

- **option A:** the salary consists of a fixed amount of \$1,900 plus \$400 per sale.
- **option B:** the salary consists of a fixed amount of \$1,900 plus an increase of 15% for each new sale.

We denote A_n and B_n respectively the salary for n sales.

1. Justify that $A_1 = 2,300$ and $B_1 = 2,185$.
2. Express A_n in terms of n .
3. Explain why B_n is a geometric sequence.
4. a) Which option gives the most attractive salary for an employee who makes 9 sales in a month?
b) Work out the most interesting option, depending on the number of sales made in a month.

Session 2026

Sujet n°3

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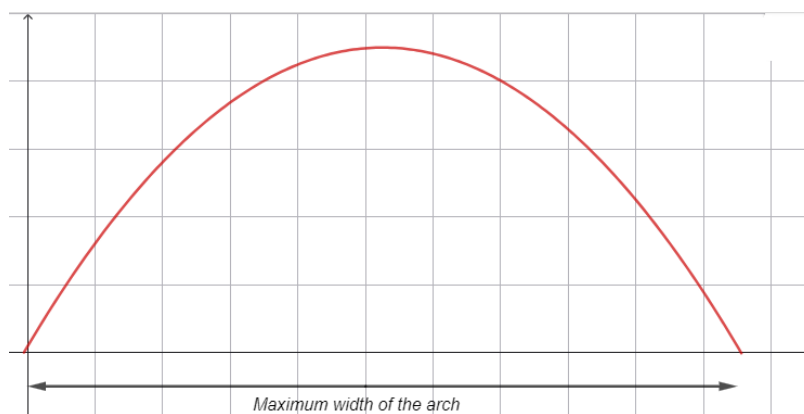
Quadratics

The arch of the Gateshead Millenium Bridge, in Newcastle, forms a parabola with the equation:

$$y = -0.016(x - 52.5)^2 + 45$$

where x is the horizontal distance (in metres) from the arch's left end and y is the distance in metres from the base of the arch.

- 1) What other famous bridge do you know? Where?
- 2) What is the maximum height of the bridge?
- 3) Give the equation of the parabola in the form: $y = ax^2 + bx + c$ where a , b , c are real numbers.
- 4) Find the maximum width of the arch (round your answer to the nearest metre).



Sujet n°04

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SEQUENCES:**Progression of an Athlete Using Arithmetic and Geometric Sequences**

Marc, a 400-meter runner, is preparing for the upcoming season and follows a structured training plan.

Part A – Arithmetic sequence (tempo work)

During an interval session, he runs several 300 m repetitions.

His coach asks him to increase his time on each repetition by 0.8 s (to work on relaxation at high effort).

On the first repetition, he runs 43.6 s.

We denote by (u_n) the sequence of times (in seconds), with $u_1=43.6$.

- 1) Explain why (u_n) is an arithmetic sequence, and compute its common difference.
- 2) Express u_n in terms of n .
- 3) Compute u_{12} and interpret it.
- 4) When will his time will exceed 53 s?

Part B – Geometric sequence (speed work)

In another session, the athlete performs short accelerations over 60 m.

His coach measures the top speed reached over the first 30 m and observes a steady 4% improvement per session.

His top speed during the first session is 9.50 m/s.

We denote by (v_n) the sequence of speeds (in m/s), with $v_1=9.50$.

- 1) Explain why (v_n) is a geometric sequence, and state its common ratio.
- 2) Express v_n in terms of n .
- 3) Compute the speed during the 6th session (give the exact form, round it to the tenth).
- 4) The coach's target is 11 m/s.
When will Marc succeed ?

What do you think tempo work and speed work respectively improve ?

Sujet n°06

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PROBABILITY:**Conditional Probability in Skiing**

A ski resort monitors safety conditions on two types of slopes: red and black.
On a given day:

60% of the skiers choose red slopes, and 40% choose black slopes.

Among the skiers on red slopes, 8% fall.

Among the skiers on black slopes, 18% fall.

Let's denote:

R: "the skier chose a red slope"

B: "the skier chose a black slope"

F: "the skier falls"

You may draw a probability tree diagram.

0. Have you ever been skiing ? Where ?

1. Compute $P(R \cap F)$

2. Compute $P(B \cap F)$

3. Compute the overall probability that a randomly chosen skier falls.

4. Given that a skier fell, find the probability they were on a black slope.

5. Interpret the result of question 4 in one or two sentences in the context of skiing safety.

Sujet n°12

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FUNCTIONS

A small business produces and sells handmade artisanal candles. The owner wishes to maximise the daily profit. The profit function P is a quadratic function depending on the number of candles x produced and sold per day.

Data collected by the business accounting system :

- When 10 candles are produced and sold, the daily profit is €180.
- The fixed costs amount to €120. Hence, when no candles are produced, the daily profit is –120 €.
- The maximum daily production capacity is 50 candles.
- When producing and selling the maximum number of candles (50), the profit becomes negative due to increased labor and raw material costs, leading to a loss of 80 €.

The owner would like to achieve a daily profit of € 400.

1. Based on the data, find the quadratic function P modeling the daily profit in terms of x , the number of candles.
2. Compute the number of candles x that maximizes the daily profit.
3. Compute the maximum possible profit according to this model.
4. Will the owner be able to reach 400 € daily profit ?

Sujet n°13

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Probability

A medical research institute has developed a new quick screening test to detect a rare virus among travellers.

According to clinical trials, the following results were obtained:

- If a person carries the virus, the probability that the test turns positive is 0.97. This is called the *sensitivity* of the test.
- If a person does not carry the virus, the probability that the test turns negative is 0.993. This is called the *specificity* of the test.

During an airport health check, a traveler is randomly selected to be tested. Let be:

- V : the event “the traveler carries the virus”
- T : the event “the test is positive”

It is known that $P(V) = 0.05$. All results should be rounded to the nearest thousandth.

1. Draw a probability tree to represent this situation.
2. Show that $P(T) \approx 0.055$.
3. Knowing that a traveler test is positive, compute the probability that they actually carry the virus.
4. The institute approves the test only if the probability that “a traveler with a positive test really carries the virus” is at least 0.9. Should they approve the test ? Justify your answer.
5. Do you know some tests? Have you, or someone you know, ever been tested for a disease?

Sujet n°14

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In 2025, a freshwater ecosystem contains 15,000 algae cells per millilitre. Observations from previous years suggest that, starting from 2026, the algae population naturally increases by 8% each year.

However, to limit harmful algal blooms¹, a biologist plans to remove 500 cells per millilitre at the end of each year, beginning at the end of 2026.

1. We denote by (u_n) the sequence representing the number of algae cells (per mL) during year $2025 + n$. Therefore : $u_0 = 15,000$.

a. Is (u_n) an arithmetic progression ? A geometric one ?

b. Justify why sequence (u_n) can be represented by the formula:

$$\text{For any whole number } n : u_{n+1} = 1.08 \times u_n - 500.$$

Which type of formula is it ?

2. For any whole number n , we now consider sequence (v_n) defined by: $v_n = u_n - 6,250$.

a. Compute v_0 .

b. Prove (v_n) is a geometric sequence with common ratio 1.08.

3. Deduce that for any whole number n , $u_n = 6,250 + 8,750 \times 1.08^n$.

4. A researcher from an environmental agency claims :

“This algal population will not explode, but unfortunately we will not succeed in reducing it to less than one third of its initial level.”

What do you think of this statement ? Justify your answer.

5. Should humans alter nature for their own interests ?

¹ Prolifération des algues

Sujet n°16

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Probability

An economic research institute has developed a screening model to assess whether a small business is likely to default on a loan¹.

We denote:

- R : the event “the business is at risk of defaulting”
- H : the event “the model classifies the business as high risk”

It is known from overall data that $P(R) = 0.12$. All probabilities should be rounded to the nearest thousandth.

According to historical data:

- If a business is at risk of defaulting (R), the model correctly identifies it as “high risk” (H) with probability 0.93 (this is called the *sensitivity* of the model).
- If a business is not at risk ($\bar{R}$), the model correctly identifies it as “low risk” ($\bar{H}$) with probability 0.97 (this is called the *specificity* of the model).

During a loan evaluation, a small business is selected at random and classified by the model.

1. Do you know if you can contract a loan for other purpose ?
2. Draw the probability tree representing this situation.
3. Compute the probability that the model classifies a randomly chosen business as high risk.
4. Given that a business is classified as high risk, calculate the probability that it actually is at risk of defaulting.
5. A bank will only approve this model if the probability that “a business classified as high risk is truly at risk” is at least 0.85.

Should the bank approve this model ? Justify your answer.

¹ Ne pas réussir à rembourser un emprunt bancaire.

Sujet n°17

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In 2020, a company generated £ 200,000 profit.

Due to rising competition, it is estimated that from 2021 onward the company's profit will decrease by 4% each year, if no other economic adjustments are made.

In addition, because of foreign investments returns , the company recieves £ 5,000 at the end of each year, starting at the end of 2021.

1. Let (u_n) be the sequence representing the company's profit (in pounds) during year $2020 + n$. Thus : $u_0 = 200,000$.
Is (u_n) an arithmetic sequence. A geometric one ?
2. Explain why sequence (u_n) can be represented by the formula :
For any whole number n : $u_{n+1} = 0.96 \times u_n + 5,000$.
3. For any whole number n , we now consider sequence (v_n) defined by: $v_n = u_n - 125,000$.
 - a. Compute v_0 .
 - b. Prove that (v_n) is a geometric sequence with common ratio 0.96.
4. Deduce that for any whole number n , $u_n = 125,000 + 75,000 \times 0.96^n$.
5. A financial expert claims :

"The company's profits will keep decreasing, but they will never fall below half of the year 2020 profit."

What do you think of this statement ? Justify your answer.

Sujet n°18

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FUNCTIONS

A tutoring company produces and sells educational video lessons. The owner wants to maximize the daily profit. The profit function P is a quadratic function depending on the number x of video lessons produced and sold per day.

Data collected by the company's accounting system :

- When 10 lessons are produced and sold, the daily profit is € 180.
- The fixed costs are € 120, so the daily profit is –120 € when no lessons are produced.
- The maximum daily production capacity is 50 lessons.
- When the maximum of 50 lessons are produced and sold, the profit becomes negative due to increased content creation costs and lower sales price, resulting in a loss of € 80.

The owner would like to achieve a daily profit of € 400.

1. Based on the data, determine a quadratic function P modeling the daily profit in terms of x , the number of video lessons.
2. Compute the number of video lessons x that maximizes the daily profit.
3. Compute the maximum daily profit according to this model.
4. Will the owner be able to reach 400 € daily profit ?

Sujet n°19

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Probability

A physics laboratory has developed a new diagnostic test to determine whether a certain material sample is superconducting.

During a quality control check, a sample is chosen at random and tested. We denote:

- S : the event “the sample is superconducting”
- P : the event “the test result is positive”

According to experiments:

- If the sample is superconducting (S), the test correctly gives a positive result (P) with probability 0.94 (this is the *sensitivity* of the test).
- If the sample is not superconducting ($\bar{S}$), the test correctly gives a negative result ($\bar{P}$) with probability 0.96 (this is the *specificity* of the test).

It is known that $P(S) = 0.10$. All results must be rounded to the nearest thousandth if necessary.

1. Draw a probability tree representing this situation.
2. Compute the probability that the test result is positive.
3. Given that the test result is positive, compute the probability that the sample actually is superconducting.
4. The laboratory will adopt this test only if the probability that “a sample with a positive test is superconducting” is at least 0.90.

Should the test be adopted ? Justify your answer.

5. Results from surveys or tests are everywhere in our daily life. What do you think of that ?

Sujet n°20

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In 2025, a solar panel produces 10,000 kWh of energy in its first year of operation. Due to gradual efficiency loss, it is estimated that from the second year onward, the annual energy production will decrease by 4% each year, if no other improvements are made.

Additionally, to compensate for this efficiency loss, the company plans to add energy-saving coatings¹ that increase energy production by 250 kWh at the end of each year, starting from the end of the second year.

1. We denote by (e_n) be the sequence representing the energy production (in kWh) during year 2025 + n . Thus: $e_0 = 10,000$.

a. Is (e_n) an arithmetic progression ? A geometric one ?

b. Justify why sequence (e_n) can be represented by the formula:

For any whole number n : $e_{n+1} = 0.96 \times e_n + 250$.

Which type of formula is this ?

2. For any whole number n , we define a new sequence (w_n) by $w_n = e_n - 6,250$.

a. Compute w_0 .

b. Prove (w_n) is a geometric sequence and determine its common ratio.

3. Deduce that for any whole number n : $e_n = 6,250 + 3,250 \times 0.96^n$.

4. An engineer claims :

"Due to the yearly efficiency loss, the panel's production decreases but will never fall below 62.5% of the first year's energy output."

What do you think of this statement ? Justify your answer.

5. Does the future of humanity rest upon renewable energy ?

¹ Surfaces isolantes

Subject n°21

FUNCTIONS

***Please, do not write on the exam paper
and do not forget to give it back at the end of the test.***

The pig pen

A pig farmer has 200m of fencing*. He wants to house his pigs in a rectangular enclosure. Each pig requires 20m².

1. If we denote x one side of the field (in meters), justify that the enclosure area is equal to :

$$A(x) = -x^2 + 100x$$

2. What is the maximum number of pigs that can be raised in this pen*?
3. What do you think about industrial animal farming ?



Pig pen, Source : [Haley McCready Outreach and Development Fund](http://haleymccreadyfund.com/?m=201112) <http://haleymccreadyfund.com/?m=201112>

Vocabulary: *fencing : clôture
*pen : enclos

Subject n°22

PROBABILITIES

***Please, do not write on the exam paper
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A pig disease

A farmer raises pigs of two different breeds*, pink and black. Black pigs make up 30% of the herd. Unfortunately, swine fever* affects some of the animals. 5% of the pink pigs are sick, but only 90% of the black pigs are healthy.

1. A pig is chosen at random from the herd*. What is the probability that it is sick?
2. The farmer says that among ten pigs chosen at random from the herd, the probability that at least one is sick is about one out of two. What do you think?
3. What do you think about industrial animal farming for human food?



Pig pen, Source : [Haley McCready Outreach and Development Fund](http://haleymccreadyfund.com/?m=201112) <http://haleymccreadyfund.com/?m=201112>

Vocabulary :

*Breed : race

*Herd : troupeau

*Swine fever : fièvre porcine

Subject n°23

SEQUENCES

***Please, do not write on the exam paper
and do not forget to give it back at the end of the test.***

A growth problem

A farmer raises pigs in semi-freedom in a 3-hectare meadow*. The herd* of 80 pigs in 2026 sees its population increase by 6% per year.

The field could currently meet the needs of 100 pigs. This capacity increases steadily, thanks to the fertilizer provided by the farmer. Each year the field could thus feed 3 more pigs than the previous year.

1. Model the evolution of the number of pigs as well as the number of animals that can be fed in this meadow.
2. When will the pigs run out of food?
3. What do you think about industrial animal farming ?



Pig pen, Source : [Haley McCready Outreach and Development Fund](http://haleymccreadyfund.com/?m=201112) <http://haleymccreadyfund.com/?m=201112>

Vocabulary :

*Meadow : pré.

*Herd : troupeau

Session 2026

Sujet n°24

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Functions

As part of quality control for a Scottish bakery, the freshness of a batch^{*} of shortbreads, fresh out of the oven, is modeled by the function F defined for all time $t \geq 0$ (in days) by the expression :

$$F(t) = 100 \times e^{-0.05t},$$

where $F(t)$ represents the percentage of freshness remaining after t days.

1. (a) Find $F(0)$ and interpret the result in the context of the shortbreads' freshness.
(b) Determine the percentage of freshness remaining after 20 days (round the result to the nearest tenth).
(c) Find $\lim_{t \rightarrow +\infty} F(t)$. Interpret this result regarding the shortbreads' preservation.
2. (a) Compute the derivative F' of the function F .
(b) Find $F'(0)$. Interpret this value?
(c) Give the table of variation of the function F .
3. The shortbreads are considered no longer saleable when their freshness $F(t)$ is less than 45.
When the shortbreads are no longer saleable (give the result in days)?

^{*} batch : lot

Session 2026

Sujet n°25

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Sequences**Part A**

A small tea shop in York sold 1,500 cups of tea in 2023. The owners plan for a steady and regular increase in sales of 120 cups each year. Let the sequence (u_n) model the number of cups sold in the year $2023 + n$, where u_0 is the number of cups sold in 2023.

1. What kind of progression is (u_n) ? Justify your answer.
2. Express the general term u_n in terms of n .
3. Using this expression, find the number of tea cups expected to be sold in 2030.
4. Work out the total number of tea cups that the shop would sell between the year 2023 and the year 2030.
5. When will the shop's sales first cross the threshold of 3,000 cups sold?

Part B

Another shop, specializing in the famous 'Earl Grey' tea, sold 2,000 boxes of tea in 2023. It aims for a 4% increase in sales each year. Let (v_n) be the sequence representing the number of boxes sold in the year $2023 + n$, where $v_0 = 2,000$.

1. What kind of progression is the sequence (v_n) ?
2. Express the general term v_n in terms of n .
3. Find the number of tea boxes expected to be sold in 2027.
4. When will the initial number of boxes sold have doubled?

Part C

Do these two models seem relevant? Explain your answer.

Session 2026

Sujet n°26

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Probabilities

Every afternoon, His Majesty The King of England has tea, with a biscuit. His choices are governed by the following probabilities, based on the statistics kept by his butler* :

1. Choice of Tea :

- The King chooses an *Darjeeling* tea (event D) with a probability of $P(D) = 0.6$.
- The King chooses an *Earl Grey* tea (event G) with a probability of $P(G) = 0.4$.

2. Choice of Biscuit :

- If he chose a *Darjeeling* tea, the probability that he has it with a *Shortbread* biscuit (event S) is 0.7.
- If he chose an *Earl Grey* tea, the probability that he has it with a *Shortbread* biscuit is 0.1.

The event $\bar{S}$ is the event where the King chooses a *Digestive* biscuit.

Assume that the King's choices are independent from one day to the next.

1. Represent this situation using a probability tree.
2. Find the probability that, on a given afternoon, the King drinks an *Darjeeling* tea and eats a *Shortbread* biscuit.
3. Show that the probability that he chooses a *Shortbread* biscuit is $P(S) = 0.46$.
4. The butler did not see the chosen tea, but notes that the King is eating a *Digestive* biscuit. What is the probability that the King drank an *Earl Grey* tea, knowing that he ate a *Digestive* biscuit?

* butler : majordome

Session 2026

Sujet n° 27

A biologist studies the evolution of a fish population in an artificial lake. Each year, 90 % of the fish survive to the next year, and an additional number of fish are introduced into the lake. To model this situation, the following recurrence relation is used:

$$u_{n+1} = 0.9u_n + 100$$

where u_n is the number of fish (in hundreds) after n years. The initial population is:

$$u_0 = 800$$

which means there are initially **80,000 fish** in the lake.

Part A

1. Explain what the constants 0.9 and 100 represent in the context of the problem.
2. Compute u_1 and u_2 and explain what they represent in the context of the problem.
3. (a) Prove by mathematical induction that $u_n = 1000 - 200 \times 0.9^n$ for all natural numbers n .
4. What can you say about the fish population in the lake in the long term?

Part B

What if no further fish were introduced (i.e., the "+100" disappears) ?



Session 2026

Sujet n° 28

AquaPure bottles and sells natural mineral water. Each day, the company can produce up to **20,000 bottles** (i.e., between 0 and 20 thousand bottles).

- The **daily production cost** (in hundreds of pounds) is modeled by the function C defined on the interval $[0, 20]$ as :

$$C(x) = 0.5x^2 - 6x + 19$$

where x is the production in thousands of bottles.

- The **daily revenue** (in hundreds of pounds) is given by :

$$R(x) = 3x$$

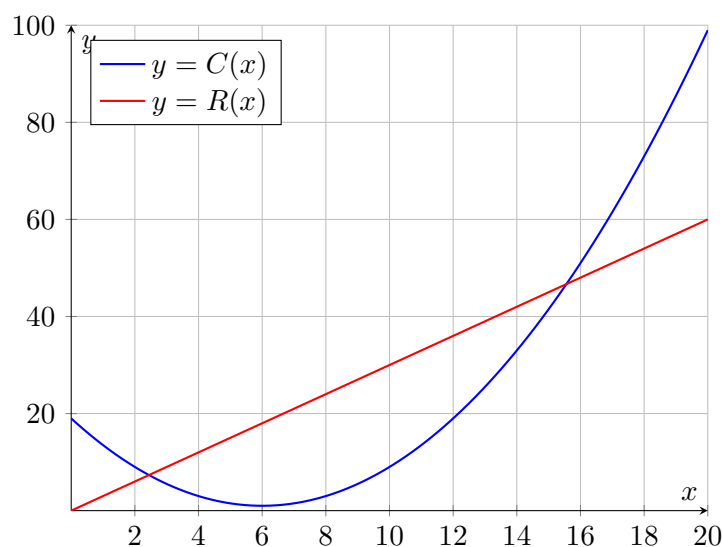
since the selling price is **£300 per 1,000 bottles**.

- The **daily net profit** is :

$$D(x) = R(x) - C(x)$$

**Part A – Graphical Analysis**

On the graph provided in the appendix, the curves C and Δ represent the functions C and R .



1. Estimate the production quantity (in thousands of bottles) at which the daily production cost is minimal.
2. Estimate the range of production quantities at which the company makes a positive profit.
3. Estimate the production quantity at which the net benefit is maximal.

Part B – Algebraic Proof

1. Show that for all $x \in [0 ; 20]$,

$$D(x) = -0.5x^2 + 9x - 19$$

2. Prove all the results conjectured in Part A.

Part C –

What do you think of the ecological impact of plastic bottles ?

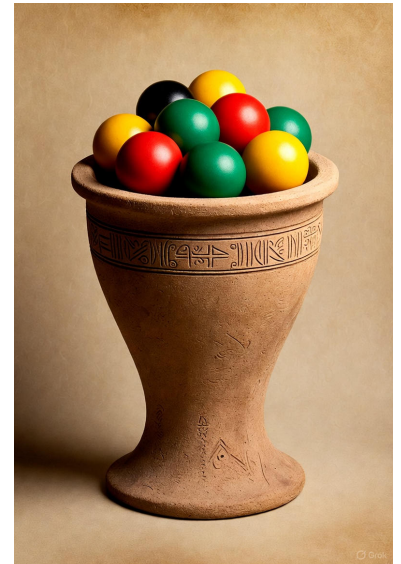
Session 2026

Sujet n° 29

A game of chance consists in randomly drawing one ball from an urn that contains 10 balls, indistinguishable to the touch, divided into four colors : 2 red (R) balls, 4 green (G) balls, 3 yellow (Y) balls and 1 black (B) ball.

The player receives a gain (or a loss) based on the color of the ball drawn :

- if the ball is red , the player gains £15.
- if the ball is green, the player gains £5.
- if the ball is yellow, the player neither gains nor loses anything.
- if the ball is black, the player loses x euros, where x is a positive real number.



1. Let G be the random variable representing the algebraic gain of the player (counted negatively when there is a loss).

Compute the value of x such that the game is fair, meaning the expected value $E(G)$ is zero.

2. A player is considered a winner if they obtain a strictly positive gain.
 - (a) What is the probability p that a player wins when choosing just one ball ?
 - (b) A player plays 4 independent consecutive rounds (the ball is replaced in the urn after each draw). What is the probability that they win exactly 4 times ? Exactly 2 times ?
 - (c) What is the average number of winning rounds in the situation described in 2. b. ?
3. What do you think about gambling like casinos or sports betting ?

Sujet n°30

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Functions**Part 1 :**

Mention some topics or fields where optimisation is used. Give some examples in every day life or in school fields.

Part 2 :

Owners of a car rental company have determined that if they charge customers p pounds per day to rent a car, where $50 \leq p \leq 200$, the numbers n of cars they rent per day can be modeled by the linear function $n(p) = 1000 - 5p$.

If they charge £50 per day or less, they will rent all their cars.

If they charge £200 per day or more, they won't rent any cars.

Assuming the company plans to charge customers between £50 per day and £200 per day to rent a car, how much should the company charge to maximize their revenue ?

How much will this company earn per day at this price ?

Help : the revenue is the product of the number of rented car (n) per day by the price charged per car and per day (p). So the revenue can be expressed in term of p .

Sujet n°31

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Sequences

Sam wants to challenge her father to build a pyramid of coins.

They will use 1 penny coins.

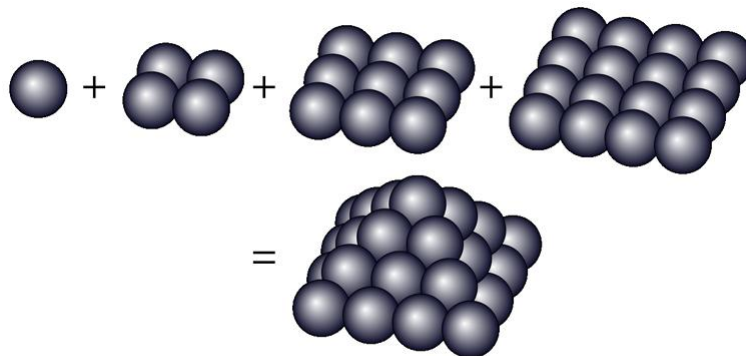
Each coin has a diameter of 20.3 mm and is 1.65 mm thick.

Each coin weighs 3.56 g.

The pyramid will be built in layers

Each layer will be made using stacks of 5 coins high.

To build the pyramid, she uses the square pyramidal numbers. So the upper layer width will be one coin less wide than the previous layer.



Geometric representation of the square pyramidal number $1 + 4 + 9 + 16 = 30$.

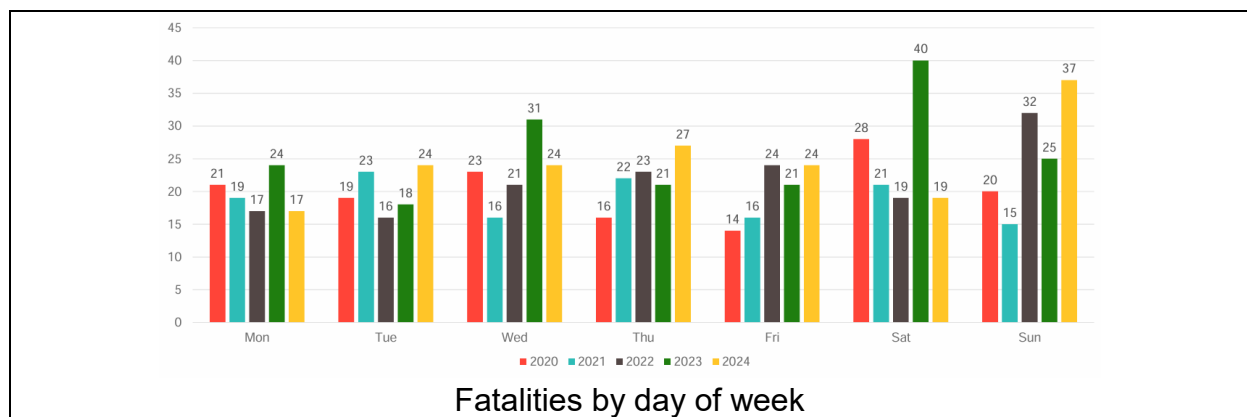
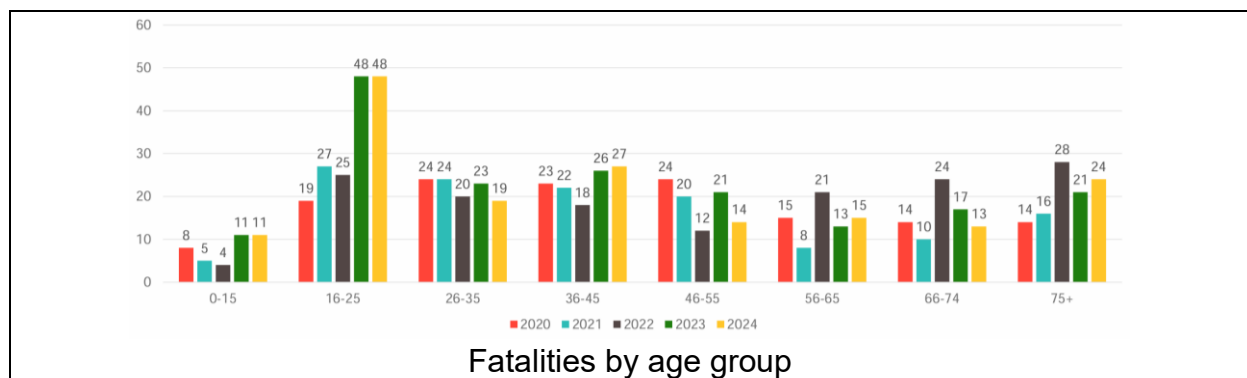
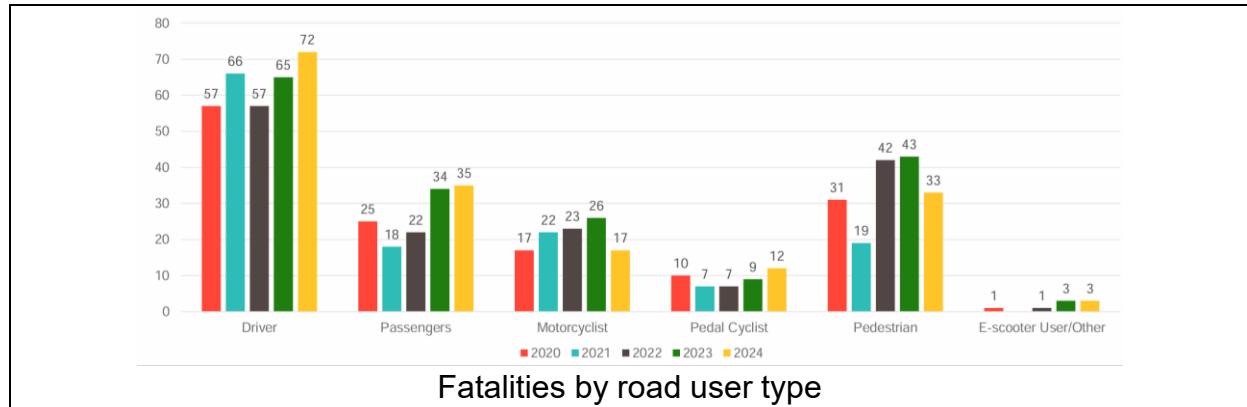
Sam and her father decide to begin with a square made of 10 coins wide.

- 1) How high will be the pyramid ? Give your answer in centimetre.
- 2) How much does the pyramid weigh ? Give your answer in kilogram.
- 3) Sam spares £62 (one penny coins only). How high will be her pyramid ?

Help : it will be useful to find the total number of coins used to build the pyramid.

Sujet n°32

Please do not write on this document and do not forget to hand it back to the jury at the end of the exam.

Probabilities and Statistics

From <https://www.rsa.ie> (Irish Road Safety website) extracts from analysis of fatalities (2020-2024)

Imagine three different questions, each one is inspired by one of these diagrams. Then answer these questions.

You can choose to focus on one specific year or work with the five years mean.

Vocabulary : E-scooter : trottinette électrique

Sujet n°35

Please do not write on this document and do not forget to hand it back to the jury at the end of the exam.

Probability

In 2024, a survey was carried out in the United Kingdom on 1,500 young people aged 15–29 about their relationship with news and journalism.

The results were as follows:

- 70% said they read news from news publishers' websites or apps at least once a week.
- Among those who read news at least once a week, 90% said that journalism plays an important role in society.
- 75% said that journalism plays an important role in society.

One person from the survey is chosen at random.

Consider the following events:

- J : "The person thinks journalism plays an important role in society."
- N : "The person reads news on publisher websites or apps at least once a week."

1. Represent this information on a probability tree diagram.
2. What is the probability that a randomly chosen young person both reads news at least once a week and thinks journalism is important?
3. Given that a person thinks journalism plays an important role in society, what is the probability that they read news at least once a week?
4. What is the probability that a randomly chosen young person does not read news at least once a week and does not think that journalism plays an important role in society?
5. Are the two events J and N independent? Justify your answer.
6. What relation do you think young people have with news and journalism in France?

Vocabulary

- **news publisher**: média d'information (journal, site d'actualité)
- **journalism plays an important role**: le journalisme joue un rôle important

Sujet n°37

Please do not write on this document and do not forget to hand it back to the jury at the end of the exam.

Sequences

Sifan Hassan claimed the final athletics gold medal of the Paris 2024 Games, winning the women's marathon in an Olympic record time of 2:22:55 on August 11th.

Usually, Sifan runs 40 km per week during her normal training period. For her preparation for the Olympic Games, her coach decided to make the training tougher. He planned to increase Sifan's weekly distance by 3 km every week, until the Olympic race.

1. Consider that in the first week of April 2025, Sifan ran 40 km in total. The Olympic preparation started then. How far did she run on the week that ends on August 4th?
2. By that time, how many kilometers had she run altogether since the beginning of her preparation?
3. Build a training program which increases her training distance to a given percentage each week, and still ensures she is ready for the competition.

A marathon is a long-distance road race of exactly 42.195 km, which is 26 miles and 385 yards.

Sujet n°37

Please do not write on this document and do not forget to hand it back to the jury at the end of the exam.

2024

January						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

February						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29		

March						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

April						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

May						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

June						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

July						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

August						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

September						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

October						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

November						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

December						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Sujet n°38
Functions

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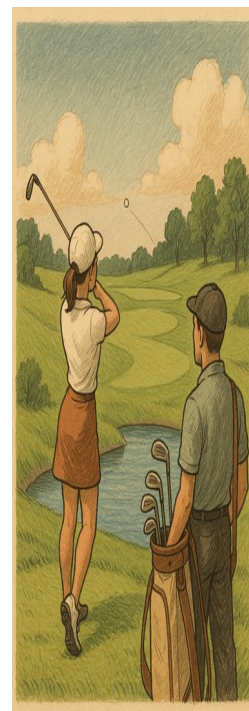
*BBC sport **Matt Nicolle: The golfer with the 400-yard drive hoping to take on the world***

Published 17 July 2018 : The sport of long drive is best compared to a home-run derby in baseball. Competitors get 165 seconds to take six shots which must land on a fairway and the longest is the winner - the more accurate you are, the more chance there is that you will win.

At last weekend's Long Drive World Series event in London, Nicolle finished second behind two-time world champion Joe Miller. But while the prize money on the main golf tours is huge - the Irish Open earlier this month had a prize fund of £5.3m with winner Russell Knox picking up £885,000 : long drive is more about the love of the game.

"There's £1,800 for first place on a European event and the top four pays out," says Nicolle, who is currently ranked 31 in the world. "There's bigger money in America, that's where long drive evolved.

1 yard $\simeq$ 0,9144 meter



Sources: Images créées par IA

It is assumed that the terrain is perfectly flat. Let consider the function, defined on $\mathbb{R}$ by :
 $f(x) = -0.08x^2 + 1.2x$. This function f models the trajectory of the golf ball, based on distance, in metre. The length of the lake is estimated to be 14 metres from the player's position.

Questions

1) Will the ball reach the other side of the lake?

2) Assume you are flying a drone somewhere above the lake. This drone is flying over the lake to take some videos. What is the minimum height it must fly at, to avoid the risk of unfortunately colliding with the golf ball?

3) **Additional questions** True / false

a) The ball reaches its maximum height at $x=15$.

b) To know whether the ball falls into the lake, we need to compute the discriminant of the quadratic function.

4) Is money too prevalent in sport ?

Sujet n°39
SEQUENCES

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The Guardian (6 March 2024)

Every step above 2,200 steps a day reduces risk of early death, study finds. Research suggests every extra step up to 10,000 reduces risk even if rest of the day is sedentary

The Guardian (by [Anna Bawden](#) Health and social affairs correspondent) Thu 24 Jul 2025

Responding to the findings, Dr Daniel Bailey, reader in sedentary behaviour and health at Brunel University of London, said the research helped "debunk the myth that 10,000 steps per day should be the target for optimal health.



📷 Experts found the lowest risk of early death was among people who took 9,000 to 10,500 steps a day. Photograph: David Davies/PA

"The real-world implications are that people can get health benefits just from small increases in physical activity, such as doing an extra 1,000 steps per day. To achieve the best reductions in risk, aiming for 5,000-7,000 per day can be recommended, which will be more achievable for many people than the unofficial target of 10,000 steps that has been around for many years."

Question 1: To begin

Have you ever heard about the target of 10,000 steps a day ?
How many steps do you think you take every day at school?

Question 2 : My training.

Today is June 1st . I want to take part in a walk on October 1st .This walk is 50 km in less than 12 hours. I have a pedometer.

To train properly, I have decided to walk gradually.

Training is organized in weekly blocks.

In week 1, I walk a total of 20,000 steps. Three training strategies are proposed. The quantity recorded is the number of steps per week.

Program A : Each week I add 2,000 steps.

Program B : Each week I increase the number of steps taken the previous week by 5%.

Program C : a mixed solution : Each week I increase the number of steps taken the previous week by 3% and I add 500 steps.

A walker, like me, is considered “prepared” if, in the final week, the weekly step count is at least 60,000. That would be about 50 km.

Question Decide which program(s) satisfy the preparation criterion.

Additional questions : True/False

- (a) A percentage-based program grows more slowly at the beginning than an arithmetic program with +2,000 steps weekly
- (b) A program increasing too fast, such as +10% every week, may be mathematically correct but unsafe for real training.
- (c) If two programs reach exactly 60,000 steps in the final week, then their total accumulated effort must be identical.