MAISON DES EXAMENS

Service Interacadémique des Examens & Concours

ANGLAIS / MATHÉMATIQUES

SECTION EUROPÉENNE

SESSION 2023

BACCALAURÉATS GÉNÉRAL ET TECHNOLOGIQUE
SESSION 2023

ÉPREUVE SPÉCIFIQUE MENTION « SECTION EUROPÉENNE OU DE LANGUE ORIENTALE »
Académies de Paris-Créteil-Versailles

Binôme : Anglais / Mathématiques

Corrigé n°1

1)

a) False

b) True

c) True

d) True (D=2r), we fine 2*Pi*r

2)

a) They are isosceles triangles at O because OC = OB = OA (radii)

b) basis angles are equal: $\angle$BCO = $\angle$CBO and $\angle$BAO = $\angle$ABO.

c) The sum is equal to 180° so:
$\alpha + \beta + (\alpha + \beta) = 180$
$2(\alpha + \beta) = 180$
$(\alpha + \beta) = 90$
So $\angle$ACB = 90°, it is a right angle

d) ABC is a right (or right-angled) triangle.

3)

a) $\angle$BAC = 90°- 62° = 28°
$\angle$BOC = 180° - 62° - 62°= 56°
We notice that $\angle$BOC = 2* $\angle$BAC

b) ABC is a right triangle from Thales' theorem. From Pythagoras' theorem,
$\mathrm{AB}^2 + \mathrm{BC}^2 = \mathrm{AC}^2$
$6^2 + 8^2 = \mathrm{AC}^2$
$36 + 64 = \mathrm{AC}^2$
$\mathrm{AC}^2 = 100$
so AC = 10, the diameter of its circumscribed circle is 10.

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Corrigé n°3

Thème : D0 – Core knowledge

1. Let’s label PQ=x. Area of PQRS = PQ x QR = 10 x. So 45=10x and x=**4.5**.

In the right-angled triangle ABC, BC=4.5, AC=9.6. So $AB^2 = AC^2 - BC^2 = 9.6^2 - 4.5^2 = 71.91$.

Thus AB=**8.5**, correct to 1 d.p. Finally the perimeter of ABCD is 2AB + 2BC=17+9=**26**.

Since AB is given correct to 1 d.p., then this result is also correct to 1 d.p.

2. 1 liter = 1000 cm^3. Total volume of the container = 30x6x19=**3420** cm^3.

2/3 of the total volume is 2280 cm3. So the total amount of water in this container is **2.28** liters.

A cup holds 0.275 liter of water. Hence the number of cups that can be filled from this container is 2.28/0.275=**8.3**, correct to 1 d.p. So 8 full cups can be filled, which amounts to 8x0.275=2.2 liters. Finally, the remaining amount of water would be 2.28-2.2 = 0.08 liter = **80 ml**.

3.

a) First, let’s calculate the position of point M on DA. DM : MA = 2 : 3 means that DA represents 2+3=5 parts. Since DA = 15 cm, then one part is 3 cm. Finally : DM = 2x3=6 cm and MA = 3x3=9 cm.

b) cos(35°) = AB/AE so cos (35) = 15/AE then AE = 15/cos(35)$\approx 18.3\ cm$ to 1dp

c) Pythagoras th:

$EM^2 = AM^2 + AE^2 = 9^2 + 18.3^2 = 415.89$

Finally, EM $\approx$ 20.4 cm

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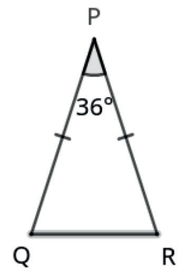
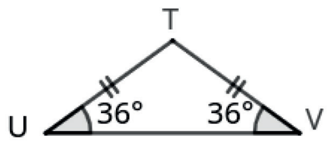
Corrigé n°4

A ***golden triangle*** is an isosceles triangle in which the ratio of the leg to the base is equal to the Golden Ratio: $\frac{PQ}{QR} = \varphi$, where $\varphi = \frac{1+\sqrt{5}}{2}$.

We admit that a golden triangle is characterized by its vertex angle: $\angle QPR = 36°$.

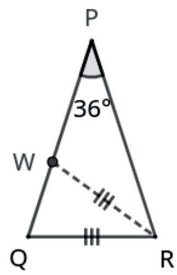


A ***silver triangle*** is an isosceles triangle in which the base angles are 36° each.



1.

a) The base angles of an isosceles triangle are congruent and the sum of the angles is 180° then $2 \times \angle PQR + 36° = 180°$; from which we deduce that $\angle PQR = 72°$.

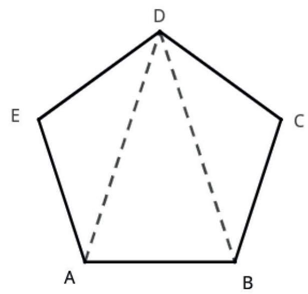


b) $\angle UTV = 180° - 2 \times 36° = 108°$.

c) The angle $\angle WQR = 72°$ is the base angle of the isosceles triangle QRW then the vertex angle $\angle QRW = 180 - 2 \times 72° = 36°$. This proves that QRW is a golden triangle.

In the triangle PWR, we have $\angle WPR = 36°$ and $\angle WRP = 72° - \angle QRW = 36°$ then PWR is an isosceles, silver triangle.

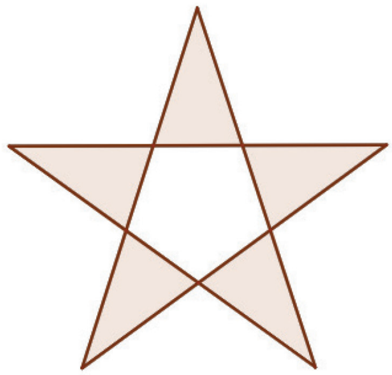
2. Let ABCDE be a regular pentagon.



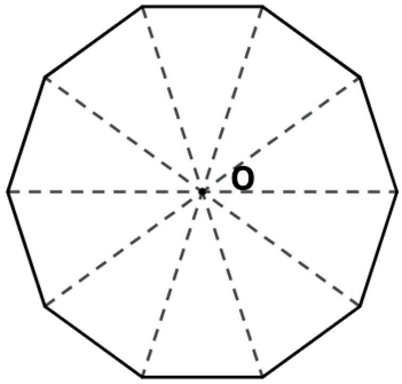
a) The sum of the interior angles of the pentagon is S = 180x3 = 540° then the interior angle $\angle AED = 540° \div 5 = 108°$. The triangle AED is isosceles and, according to question 1b, it is a silver triangle.

b) Since $\angle EAD + \angle DAB = 108°$, we have $\angle DAB = 108 - 36$ (because EAD is a silver triangle) = 72°. ABD is an isosceles triangle (due to symmetries in the regular pentagon) and, according to question 1a, it is a golden triangle.

3. The shaded triangles are isosceles, due to symmetries in the regular pentagon.
Using supplementary angles, we find that the base angles of the shaded triangles are equal to 180 – 108 = 72°.
According to question 1a, this proves that they are golden triangles.



4. Since all the ten angles at the vertex O add up to 360°, we deduce that each vertex angle of the isosceles triangles is equal to 360 ÷ 10 = 36°. This proves that they are golden triangles.



5. Fibonacci sequence? Length of the diagonal of a regular pentagon with side = 1?

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Corrigé n°5

Domaine D0

Archimedes and Pi

1. The perimeter is $P=2\pi R$. Or $R=1$ so $P=2\pi$
2. OAB is a equilateral triangle so OA=OB=AB. Thus AB=1
3. $p_1=6AB=6$ so $2\pi\approx 6$ and $\pi\approx 3$
4. AOB is a equilateral triangle so S is the midpoint of [AB] Using the Pythagorean theorem in the Right triangle OSA , we have $OA^2=OS^2+SA^2$ so $1^2=OS^2+(1/2)^2$ so $OS^2=(3/4)^2$ so OS=sqrt(3)/2
Or OG=1 so SG=1-sqrt(3)/2
5. Using the Pythagorean theorem in the Right triangle SGA we have $GA^2=GS^2+SA^2$ so $GA^2=(1-\text{sqrt}(3)/2)^2+(1/2)^2$ so $GA^2=2-\text{sqrt}(3)$ So GA=sqrt(2-sqrt(3))
6. $P_2=12*\text{sqrt}(2-\text{sqrt}(3))$ so $\pi\approx 3.1058$

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Corrigé n°6

1°) a) 13.6/7.65 = 1.778 (rounded to 3 d.p.) then 13.6/7.65 = 16/9.

b) According to the Pythagoras' theorem, the length d of the diagonal satisfies the equality : $d^2 = 13.6^2 + 7.65^2 = 243.4825$ hence $d = \sqrt{243.4825} = 15.60$ inches (rounded to 2 d.p.).

2°) a) The aspect ratio of a square is 1:1 (or 1.0).

b) Since 16/9 = 1.778 is greater than 4/3 = 1.333 (to 3 d.p.), the screen with an aspect ratio of 4:3 is the one with the shortest width, i.e. screen B.

c) 16/9 is equal to the square of 4/3.

3°) a) According to the Pythagoras' theorem, $h^2 + w^2 = 6.5^2 = 42.25$

b) $(2.7)^2 + w^2 = 42.25 \quad \Leftrightarrow \quad w^2 = 42.25 - 7.29$

$$\Leftrightarrow \quad w^2 = 34.96$$

$$w = \sqrt{34.96} \approx 5.9$$

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Corrigé n°7

1) Going upstream, the current is pushing against the boat so the resulting speed is B-C.

$S = \frac{D}{T}$ so $B - C = \frac{40.5}{4.5}$.

Going downstream, the current is pushing the boat, so the resulting speed is B+C.

So $B + C = \frac{45}{3}$.

We need to solve $\begin{cases} B - C = 9 \\ B + C = 15 \end{cases}$.

2) Therefore, $\begin{cases} C = B - 9 \\ 2B = 24 \end{cases}$ $\begin{cases} C = 3 \\ B = 12 \end{cases}$

The speed of the boat is 12mph and the speed of the current is 3mph.

3)

step 1: rearrange one of the equations into the form $x = \cdots$ or $y = \cdots$;
step 2: substitute the right-hand side of this equation into the other equation in place of the variable on the left-hand side ;
step 3: expand and solve this equation ;
step 4: substitute the value into the $x = \cdots$ or $y = \cdots$ equation ;
step 5: check that the two values found satisfy the original equations.

4) Solving simultaneous equations graphically:

You have to graph both equations and look for the intersection point of the two lines.

If there is no intersection point (if the two lines are parallel), there is no solution.

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Corrigé n°8

1. **a)** $\frac{360}{8} = 45°$.

b) OAB is an isosceles triangle with apex O. The base angles are equal to $\frac{180-45}{2} = \frac{135}{2} = 67.5$. Since OAH and OAB are congruent triangles, the angles OAH and OAB are the same measure, then angle BAH measures $67.5 \times 2 = 135°$.

2. **a)** Using question 1, it is known that angle BAH measures $135°$. Since H is due West form A, then its bearing is $270°$. Finally, subtracting both, the bearing of B from A is $135°$.

b) In the triangle BAH, isosceles with apex A, the base angles are equal to $\frac{180-135}{2} = 22.5$. Using co-interior angles, the angle from the north direction, counted anticlockwise is $180 - 135 = 45°$. Finally the bearing of H from B is $360 - 45 - 22.5 = 292.5°$.

3. To complete one side of the octagon, it will take the boat $\frac{1.35}{45} = 0.03$ hour, which corresponds to $0.03 \times 60 = 1.8$ minute. To complete the 8 sides of the route, it will take $8 \times 1.8 = 14.4$ minutes.

4. Let's label K, the point due North from B and due East from A. Using the reasoning in question 2b, since K is North from B and angle KBA measures $45°$, then BKA is an isosceles right angled-triangle, with apex K. Then we have $\mathrm{AK} = \frac{AB}{\sqrt{2}} = \frac{1.35}{2}\sqrt{2}$. Since $\mathrm{AH} = 1.35$, we deduce that $\mathrm{HK} = 1.35 + \frac{1.35}{2}\sqrt{2} = 2.3$ correct to the nearest tenth.

Finally, using the cosine ratio in the right-angled triangle BKH, we get : $\mathrm{HB} = \frac{\mathrm{HK}}{\cos(22.5)} = 2.5$ km, correct to 1 d.p.
Or : using Pythagora's theorem, $BH^2 = BK^2 + (HA + AK)^2$ from which we deduce BH.

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Corrigé n°10

Part 1

1) a) Ω = { B1B1 ; B1B2 ; B1B3 ; B2B1 ; B2B2 ; B2B3 ; B3B1 ; B3B2 ; B3B3 }.

b) A = { B1B1 ; B2B2 ; B3B3 }.

$P(A) = \frac{3}{9} = \frac{1}{3}$.

2) a)

	P1	P2	P3	P4	P5	P6
P1	X					
P2		X				
P3			X			
P4				X		
P5					X	
P6						X

There are 30 outcomes.

b) A = { P1P2 ; P2P1 ; P3P4 ; P4P3 ; P5P6 ; P6P5 }.

$P(A) = \frac{6}{30} = \frac{1}{5}$.

3) The probabilities are different whereas the situation appears to be the same. In fact, the two experiments are completely different! The universal sets are not the same.

Part 2

1) $100a + 10b + c = 99a + 9b + a + b + c = 3(33a + 3b) + a + b + c$, so the number is divisible by 3.

2) Using the same method,

$100a + 10b + c = 99a + 9b + a + b + c = 9(11a + b) + a + b + c$.

3) By 2, by 5, by 10.

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Corrigé n°11

1) $1260 - 18 \times 25 = 810$

$810 : 15 = 54$

There are 54 tents today.

2) Solve $x - \frac{4.5x}{100} = 37054$

$100x - 4.5x = 3705400$

$95.5x = 3705400$

$$x = \frac{3705400}{95.5} = 38800$$

The total income in August were £38 800.

3) a) women : children = 3 : 7 so women : 224 = 3 : 7 then $women = 3 \times 224 : 7 = 96$.

men : women = 5 : 4 so men : 96 = 5 : 4 then $men = 5 \times 96 : 4 = 120$.

There are 96 women and 120 men.

b) Number of people : 224 + 96 + 120 = 440
Then the probability is $\frac{224}{440} = \frac{28}{55}$

c) 15 : 12 : 28

4) The upper bound is $6 \times 8 = 48m^2$

5) $\mathrm{V} = \frac{2\times 3}{2} \times 4 = 12$
The volume of the tent is 12 cm^3.

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Corrigé n°13

Part A

1) 249:195 = 81:65 (we have divided by 3)
2) 100-58= 42 so 42% of women.
$$\frac{42}{100} * 249 = 104,58 \approx 105\ women$$
3) $\frac{91}{100} * 249 = 226,59 \approx 227$
   227 injured while riding an electric scooter.

   249– 227 = 22
   22 pedestrians injured by an electric scooter.

4) 40% (head injuries) + 32% (bone fractures) + 28% (contusions, sprains and lacerations) = 100% So NO other types of injuries.

5) Number of injured riders: 227

   Number of injured riders with no helmet : 227 -10 = 217
   217/227 * 100 ≈ 96%

Part B

up to you!

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Corrigé n°1

	Distance in km	Rate in km/h	Time in h
First part of the trip	100	r	t
Second part of the trip	200	$r+30$	$t-1$
Total	300		$2t-1$

1. **a**. Distance = Rate × Time
   b. $100 = r \times t$
   c. $200 = (r+30) \times (t-1)$
   d. $200 = (r+30) \times \left(\frac{100}{r} - 1\right)$
   e. $200 = 100 - r + \frac{3000}{r} - 30$

$$130 = -r + \frac{3000}{r}$$

$$130r = -r^2 + 3000$$

2. $r^2 + 130r - 3000$=0

$r = 20$ or ~~$r = -150$~~

Her rate over the first part of the trip was 20 km/h.

3.

	Distance in km	Rate in km/h	Time in h
First part of the trip	100	20	5
Second part of the trip	200	50	4
Total	300		9

3. Average speed for the whole trip is : $\frac{total\ distance}{total\ time} = \frac{300}{9} \approx 33.3$ km/h

The average of the speeds is : $\frac{20+50}{2} = \frac{70}{2} = 35$ km/h.

The two are different.

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Corrigé n°2

1. BM=5-x
2. You apply Pythagoras' theorem : $MN^2 = (5-x)^2 + x^2 = 2x^2 - 10x + 25$

$$MN = \sqrt{2x^2 - 10x + 25}$$

3. f(x)=MN²=2x²-10x+25
4. domain : [0 ;5]
5. U-shaped parabola

   Vertex (5/2 ;25/2) (x-coordinate of the vertex –b/(2a) ; y-coordinate : image of the x-coordinate under f)

   Axis of symmetry x=5/2
6. Min area : y-coordinate of the vertex : 25/2 = 12.5 cm²
7. f(1)=17 cm²
8. [12.5 ; 25] since f(0)=f(5)=25
9. a) discriminant = 20 ; 2 roots $\frac{5\pm\sqrt{5}}{2} \approx 1.38\ cm\ and\ 3.62\ cm$

   b) previous solutions : 1.38/2.54=0.54 in and 3.62/2.54=1.43 in

   area : 15/(2.54²)=2.33 square inches

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Corrigé n°3

1) Different methods. For instance: the y-intercept is 15 so it is not C=15d+5.

And the line passes through (1,20) which is correct with the formula C=5d+15, not with the other one.

2) Different methods. For instance you can plot the line and notice that the two lines cross each other at d=2

Then from 2 days, the cost of hiring a road bike is greater than the cost of hiring a mountain bike. Jane is not right.

3) **a)** h(0)=500 metres

b) h is represented by a parabola. x-coordinate of the vertex : -b/(2a)=3/2

Maximum height: h(3/2)=2300 metres

c) you have to solve h(t)=1000

$-800t^2+2400t-500=0$

Discriminant = 4 160 000 >0

So two roots: roughly 2.77h and 0.23h i.e. 2h46 min and 14 min after the beginning

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Corrigé n°4

1. $a + b = 80$ and $16a + 4b + 50 = 50$.
After solving the system, $a = -10$ and $b = 40$.

2. The ball reaches its maximum height at $t = -\frac{40}{2\times(-10)} = 2$s.
Its maximum height is $h(2) = 90$m.

3. Solve the equation $h(t) = 0$. The ball touches the ground at $t = 5$s.

4. As the leading coefficient is negative, we have a curve that opens downwards: h is increasing from 0 to 2 and decreasing from 2 to 5. Function h reaches its maximum at $t = 2$ and $h(2) = 90$.

5. Solve the inequality $h(t) > 70$. The ball is higher than 70m approximately between 0.6s and 3.4s.

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Corrigé n°5

Sujet n°**Voillaume-D1 (corrigé)**

1. $20t$.
2. The second cyclist leaves 1 hour later, so the time he takes for the journey is 1 hour less than the time taken by the first cyclist.
3. Using Pythagoras Theorem, we have :

$$(20t)^2 + (40(t-1))^2 = 100^2$$

$$400t^2 + 1600(t-1)^2 = 10000$$

$$t^2 + 4(t-1)^2 = 25$$

$$5t^2 - 8t - 21 = 0$$

4. Using the quadratic formula, we find $t = 3$ hours.

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Corrigé n°8

1) $0 \leq x \leq 6$

2) $x(6-x)$

3) a parabola

4) The image of 5 is 5.

5) The preimages of 8 are 2 and 4.

6) $x(6-x) = 6x - x^2$

7) $-\frac{b}{2a} = \frac{-6}{-2} = 3$ and $f(3) = 9$.

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Corrigé n°10

1) parallelogram

2) 15 cm² when x=0, it is the same rectangle as ABCD.

3) a) $\frac{x\times(5-x)}{2}$

b) $\frac{x\times(3-x)}{2}$

c) $15-\frac{2\times x\times(5-x)}{2}-\frac{2\times x\times(3-x)}{2}=15-x\times(5-x)-x\times(3-x)=15-5x+x^2-3x+x^2=2x^2-8x+15$

4) Solve A(x)=9.
Delta : 16
Solutions : 1 and 3

5) x min = 8 / (2*2)= 2
$\text{A}(2)=2\times 2^2-8\times 2+15=8-16+15=7$
MNPQ will have an area of 7 cm² minimum when x=2.

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Corrigé n°11

Domaine 1

Reminders :

Any quadratic function can be written as: $f(x) = ax^2 + bx + c$.

Its curve is a parabola which has a vertex for $x = -\frac{b}{2a}$.

The discriminant of a quadratic trinomial is the expression $b^2 - 4ac$.

- If this expression is negative, the trinomial has no real root.
- If this expression equals zero, the trinomial has a double root: $x = -\frac{b}{2a}$.
- If this expression is positive, the trinomial has two different real roots: $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$.

Exercise :

To celebrate the end of the year, fireworks are launched in a park from a platform 29 feet off the ground. The height, en feet, of the fireworks can be modeled as a function of time t, in seconds, using the function $h(t) = at^2 + bt + c$, where a, b and c are real numbers.

It is also known that after 1 second, the fireworks are at an altitude of 125 feet, and after 2 seconds, its altitude is 189 feet.

1. Using the information above, explain why $c = 29$.

2. Explain why the data can be expressed as $\begin{cases} a + b = 96 \\ 2a + b = 80 \end{cases}$.

3. Solve the system above and show that $h(t) = -16t^2 + 112t + 29$.

4. Describe the graph of the function $h(t)$.

5. Suppose one of the fireworks does not go off** as intended. Where does it land back on the ground ? Explain your work.

6. Determine the maximum altitude a firework can reach.

7. The fireworks must go off at least at 200 feet from the ground, to ensure the safety of the onlookers. In what time-interval could the fireworks go off? Explain your work.

****go off = explode**

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Binôme : Anglais / Mathématiques

Corrigé n°12

MAPPING / Sujet D1

The first part of this page is a summary which will help you solve the following exercise.

Any quadratic function can be written as: $f(x) = ax^2 + bx + c$.

Its curve is a parabola which has a vertex for $x = \frac{-b}{2a}$.

Any quadratic trinomial can be written as: $ax^2 + bx + c$.

Its discriminant is the expression $b^2 - 4ac$.

If this expression is negative, the trinomial has no real root.

If this expression equals zero, the trinomial has a double root: $x = \frac{-b}{2a}$.

If this expression is positive, the trinomial has two different real roots:

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Exercise

A businessman has just moved into Mathville, a city situated in California. He wants to build an amusement park on the large plain that stretches just outside of town. He needs a permit from the Mayor.
"What surface area do you need?", asks the Mayor.
"About 200 square miles", answers the businessman.
"All right", says the Mayor, "You may choose a rectangular piece of land. Its dimensions must be such that if the width of the rectangle were 11 miles longer and the length 9 miles longer, the area of the rectangle would be three times greater. Besides, its perimeter must be equal to 58 miles".
The businessman duly selected his land in accordance with these conditions. But he got away with eight square miles more than what the Mayor had anticipated.

1) Make a short presentation of the text.

2) Let W be the width of the rectangle and L be its length. Prove that solving the problem is the same as solving the following system : $\begin{cases} W + L = 29 \\ 2WL = 11L + 9W + 99 \end{cases}$.

3) Show that solving this system relies on solving the equation $2W^2 - 60W + 418 = 0$.

4) What was the value the Mayor had in mind?

5) A second businessman wants to build a zoo near the city on a piece of land shaped as a square whose surface area is equal to 4 mi^2.

a. Compute the perimeter of the square.

b. Knowing that ten miles of fencing cost half a million dollars, how much will it cost to build a fence around the park?

c. The businessman is offered a 15 % discount. How much will he pay then for the fence?

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Corrigé n°13

Correction D1

a) $(x-a)^2-3=x^2-2ax+a^2-3$
Therefore, a=1

b) disc= $11^2-4\times 2\times(-6)=121+48=169$
$\sqrt{169}=13$
root1 = $\frac{-11+13}{2\times 2}$ and root 2 = $\frac{-11-13}{2\times 2}$
root1 = $\frac{1}{2}$ and root 2 = -6
$\frac{1}{2}\times -6=-3$ so b= -3

c) disc= $2^2-4\times 3\times 1=4-12=-8$

So c = 0

d) $xmin=\frac{-18}{2\times 1}=-9$
$d(-9)=(-9)^2+18\times(-9)+85$
$d(-9)=81-162+85$
$d(-9)=4$

So $d=4$

e) x-3 = -3x+21
4x = 24
x= 6

y = 6-3=3

So e = 3

f) $x^2+6x+10=2$
$x^2+6x+8=0$
disc= $6^2-4\times 1\times 8=36-32=4$
$\sqrt{4}=2$
S1 $=\frac{-6+2}{2}=-2$ and S2 $=\frac{-6-2}{2}=-4$

The greatest is -2 so f=-2

Conclusion: Magic square

1	-4	3
2	0	-2
-3	4	-1

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Corrigé n°1

Thème : dérivation / Differentiation

1) The radius of the circle is the width of the rectangle. Therefore, the radius is x cm.

2) The perimeter is 60 cm. Then: $x + 2 \times y + x + \frac{1}{4} \times 2\pi \times x = 60$

Thus $2y = 60 - 2x - \frac{1}{2}\pi x$ and $y = 30 - x - \frac{1}{4}\pi x$

3) $A = x \times y + \frac{1}{4} \times \pi x^2 = x\left(30 - x - \frac{1}{4}\pi x\right) + \frac{1}{4} \times \pi x^2 = 30x - x^2 - \frac{1}{4}\pi x^2 + \frac{1}{4}\pi x^2 = 30x - x^2$.

4) a) A is a quadratic function. The derived function is $A'(x) = 30 - 2x$.

The derivative is 0 when $x = 15$: for $x = 15$, A is stationary.

b) $A(15) = 30 \times 15 - 15^2 = 225$

Furthermore, if $x < 15$ then $2x < 30$ and $A'(x) > 0$ and if $x > 15$ then $A'(x) < 0$.

The sign of $A'(x)$ is $+$ on the left of 15 and – on the right, so the function A has a maximum value at $x = 15$ which is 225 cm².

c) The dimensions of the plate are $x = 15$ cm, $y = 15 - \frac{15}{4}\pi \approx$

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Corrigé n°2

Part A

1. $\begin{cases} f(10) = 120 \\ f(20) = 210 \\ f(90) = 0 \end{cases}$ $\begin{cases} 100a + 10b + c = 120 \\ 400a + 20b + c = 210 \\ 8100a + 90b + c = 0 \end{cases}$

2. $\begin{cases} 100a + 10b + c = 120 \\ 400a + 20b + c = 210 \\ 8100a + 90b + c = 0 \end{cases}$ $\begin{array}{rr} -2R_1: & -200a - 20b - 2c = -240 \\ \underline{R_2:} & \underline{400a + 20b + c = 210} \\ & 200a - c = -30 \end{array}$

$\begin{cases} 100a + 10b + c = 120 \\ 200a - c = -30 \\ 8100a + 90b + c = 0 \end{cases}$ $\begin{array}{rr} -9R_1: & -900a - 90b - 9c = -1080 \\ \underline{R_3:} & \underline{8100a + 90b + c = 0} \\ & 7200a - 8c = -1080 \end{array}$

$\begin{cases} 100a + 10b + c = 120 \\ 200a - c = -30 \\ 7200a - 8c = -1080 \end{cases}$ $\begin{array}{rr} -8R_2 & -1600a + 8c = 2400 \\ \underline{R_3:} & \underline{7200a - 8c = -1080} \\ & 5600a = -840 \end{array}$ donc $a = \frac{-840}{5600} = -0.15$

$\begin{cases} 100a + 10b + c = 120 \\ 200 \times (-0.15) - c = -30 \\ a = -0.15 \end{cases}$ $\begin{cases} 100a + 10b + c = 120 \\ 200 \times (-0.15) - c = -30 \\ a = -0.15 \end{cases}$ $\begin{cases} 100 \times (-0.15) + 10b + 0 = 120 \\ c = 0 \\ a = -0.15 \end{cases}$

$\begin{cases} b = 13.5 \\ c = 0 \\ a = -0.15 \end{cases}$

Part B:

1. $f(30) = 0.15 \times 30 \times (90 - 30) = 270.$
   There are 270,00 patients 30 days after the first cases.

2. $f(t) = 0.15 \times t \times (90 - t) = -0.15t^2 + 13.5t$
   $\frac{-b}{2a} = \frac{-13.5}{2\times(-0.15)} = 45$ and $f(45) = 0.15 \times 45 \times (90 - 45) = 303.75.$
   The maximum number of patients is 303,750 patients. It occurs 45 days after the first cases.

3. We want to find t such that $f(t) \geq 270$
   We solve the inequation : $-0.15t^2 + 13.5t \geq 270$, i.e. $-0.15t^2 + 13.5t - 270 \geq 0.$
   $\Delta = 13.5^2 - 4 \times (-0.15) \times (-270) = 20.25$
   $x_1 = \frac{-13.5 - \sqrt{20.25}}{2\times(-0.15)} = 60$ and $x_2 = x_1 = \frac{-13.5 + \sqrt{20.25}}{2\times(-0.15)} = 30$
   As the parabola opens downwards, $f(t) \geq 270$ for t between 30 and 60.
   The hospital is under stress for 30 days.

4. $h = 303.75$ and $b = 90 - 0 = 90$,

thus the area under the parabola is : $\frac{2}{3}b \times h = \frac{2}{3} \times 90 \times 303.75 = 18{,}225$.

And the average number of patients during the epidemic was $\frac{18{,}225}{90} = 202.5$ in thousands,

Thus the average number of patients during the epidemic was 202,500 per day

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Corrigé n°3

Domaine : Differentiation

1) **a)** C1 is the curve ‘empty stomach’ and C2 the curve ‘after eating’.

b) With an empty stomach (C1): roughly 1,5 g/l after 1 hour

after eating (C2): roughly 1 g/l after 1 hour either.

c) With an empty stomach: after 3h, the BAC is approximately equaled to 0.6 g/l. Thus, not allowed to drive in Scotland. It’s just possible in England and Wales.

After eating: the BAC is approximately equaled to 0.4 g/l. Thus, it’s allowed to drive in Scotland, in England and Wales.

d) As soon as the alcohol is drunk (t=0). Indeed, the tangent with the highest gradient is at t=0.

2) **a)** ok (product rule and exponential)

b) $f'(t) = 0$ if, and only if, $t = 1$ and $f'(t) > 0$ if, and only if, $t < 1$. Therefore, the maximum value of f is $f(1) = \frac{2}{e} \approx 0{,}736 g/l$ after 1 hour.

c) We are in Scotland, thus Eliott must when $f(t) \leq 0.5$ over $I = [1; +\infty[$.

f is decreasing over $[1; +\infty[$.

$f(2) > 0.5$ and $f(3) < 0.5$ therefore he must wait more than 2 hours and less than 3.

$$10min = \frac{1}{6}h$$

$f(2) > 0.5$ and $f\left(2 + \frac{1}{6}\right) < 0.5$ therefore he must wait more than 2 hours and less than 2h10.

Eliott should wait 2h10 before being allowed to drive in Scotland.

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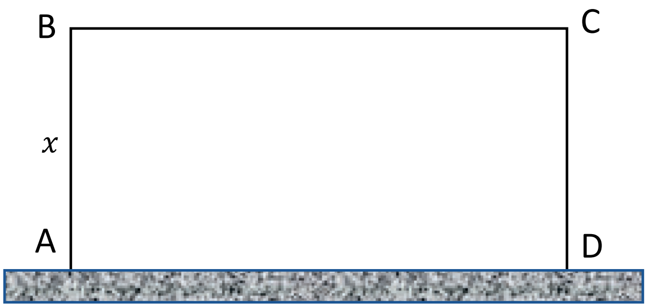
Corrigé n°4

DIFFERENTIATION

Exercise 1

Emmy wants to build a rectangle enclosure for her animal (a goat) with a surface of 800 square feet. In order to minimize the coasts, she plans to build it against a wall of her house and wonders which minimum length of barrier she has to buy to surround the enclosure on the sides.
She drew the figure below.



1. Let's call x the length AB. Explain how to find the expression of the length BC then compute the expression of the barrier's length.

The area of the enclosure which is a rectangle is 800 sq.ft so :

$$AB \times BC = 400 \Leftrightarrow BC = \frac{800}{AB} \Leftrightarrow BC = \frac{800}{x}$$

The barrier's length is: $L = AB + BC + CD \Leftrightarrow L = 2x + \frac{800}{x}$ because as ABCD is a rectangle, $AB = CD$.

2. Let f the function defined by $f(x) = 2x + \frac{800}{x}$. What does represent this function? What should be the range of the study?

We notice that $f(x) = L$ so the function f represents the length of the barrier.
As x is a length, it can't be negative so we can study the function on $]0; +\infty[$ (it seems difficult to consider that x could be less than 1 foot so a study on [1 ; 800] is convenient).

3. Work out f', the derivative function of f, and find the sign of f' to determine where the function is increasing and where it is decreasing.

$\forall x \in]0;+\infty[, f'(x) = 2 - \frac{800}{x^2}$
$\Leftrightarrow f'(x) = \frac{2x^2-800}{x^2}$
$\Leftrightarrow f'(x) = \frac{2(x^2-400)}{x^2}$
$\Leftrightarrow f'(x) = \frac{2(x-20)(x+20)}{x^2}$

$x^2 > 0$ on the range of study.
On $]0;20[$, $f'(x) < 0$ so f is decreasing
On $[20;+\infty[$, $f'(x) \geq 0$ so f is increasing.
There is minimum for $x = 20$

4. What is the minimum length of the barrier she has to build?

The minimum is for $x = 20$ feet so the length of the barrier she has to build is $f(20) = 2 \times 20 + \frac{400}{20} = 60$ feet.

- ➔ We can notice the enclosure is a square.
- ➔ Possible questions on conversion foot/cm

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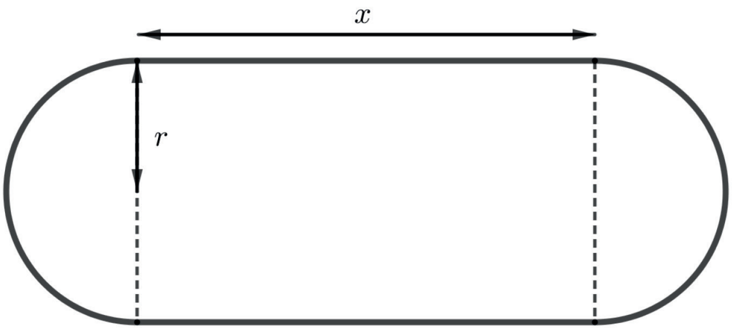
Corrigé n°5

Domain 2



The figure above shows the design of a stadium track and field track. The track consists of two semicircles, each of radius r metres, joined up to a rectangular section of length x metres. The total length of the track is 400 metres. The area $\mathcal{A}(r)$ depends on the value of r.

1) Using the total length of the track, show that $x = 200 - \pi r$.

2) Deduce that the expression of the area is $\mathcal{A}(r) = 400r - \pi r^2$.

In order to hold field events safely, it is required for the area enclosed by the track to be as large as possible.

3) Explain why there is a value of r at which the area $\mathcal{A}(r)$ reaches a maximum and then calculate it.

4) Show that the maximum area enclosed by the track is $\frac{40\,000}{\pi}\ m^2$.

5) Explain why the resulting shape of the track may not be suitable.

6) Do you know any other method to find the maximum value of the area ?

7) Using the total length of the track, show that $x = 200 - \pi r$.

$$\mathcal{P} = 400$$
$$\mathcal{P} = 2\pi r + 2x$$

$$2\pi r + 2x = 400$$
$$x = 200 - \pi r$$

8) Deduce that the expression of the area is $\mathcal{A}(r) = 400r - \pi r^2$.

$$\begin{aligned}\mathcal{A} &= 2xr + \pi r^2 \\ &= 2(200 - \pi r)r + \pi r^2 \\ &= 400r - 2\pi r^2 + \pi r^2 \\ &= 400r - \pi r^2\end{aligned}$$

In order to hold field events safely, it is required for the area enclosed by the track to be as large as possible.

9) Explain why there is a value of r at which the area $\mathcal{A}(r)$ reaches a maximum and then calculate it.

Parabola with $a < 0$. Turned downwards.

$$r = -\frac{b}{2a} = \frac{200}{\pi}$$

10) Show that the maximum area enclosed by the track is $\frac{40\,000}{\pi}\ m^2$.

$$\begin{aligned}\mathcal{A}_{max} &= 400 \times \frac{200}{\pi} - \pi \times \left(\frac{200}{\pi}\right)^2 \\ &= \frac{80000}{\pi} - \frac{40000}{\pi} \\ &= \frac{40000}{\pi}\ m^2\end{aligned}$$

11) Explain why the resulting shape of the track may not be suitable.

When $r = \frac{200}{\pi}$, we have, using the length of the track :

$$x = 200 - \pi r = 200 - \pi \times \frac{200}{\pi} = 0$$

For the area to be maximal, the track should be a circle.

12) Do you know any other method to find the maximum value of the area ?

Using derivatives !

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Corrigé n°6

1°) The volume is $V = 3 \times x \times h$.

2°) $h = \frac{180}{3x} = \frac{60}{x}$.

3°) Four rectangles for the basis + closure: $4 \times 3x$

Vertical rectangles: $2 \times xh + 2 \times 3h = 120 + \frac{6\times 60}{x}$

Therefore the total area of the box is $A(x) = 12x + 120 + \frac{360}{x}$.

4°) $A'(x) = 12 - \frac{360}{x^2}$

5°) For $x > 0$, $A'(x) \geq 0 \iff x \geq \sqrt{30}$

6°) The minimal area of the box is $A(\sqrt{30}) \approx 251$ square inches.

Since one inch is 2.54 cm, one square inch is 6.4516 square centimeters and the area of the box is 1622 cm².

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Corrigé n°7

Domaine 2 : Differentiation

1) $f(0) = 25$

2) $f(31) = \frac{-31^2}{2} + 20 \times 31 + 25 = 164.5$

3)

a) $f'(x) = -x + 20$

b)

x	0	20	31
f'(x)	+	0	-

4)

a)

x	0	20	31
f	$\nearrow$		$\searrow$

b) On day 20.

c) The population increases during the first 20 days then decreases during the last 11 days. We can imagine that there aren't any resources left after 20 days.

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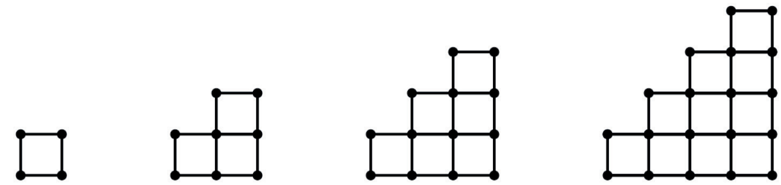
Corrigé n°1

Thème : suites/sequences

1)



2) $u_1 = 4 \qquad u_2 = 10 \qquad u_3 = 18$
$u_2 - u_1 = 6$ and $u_3 - u_2 = 8$ therefore u_n isn't an AP.

$\frac{u_2}{u_1} = 2{,}5$ and $\frac{u_3}{u_2} = 1{,}8$ therefore u_n isn't a GP.

3)

Step n	1	2	3	4
u_n = number of lines	4	10	18	28
n^2	1	4	9	16
$v_n = u_n - n^2$	3	6	9	12

4) a) v_n seems to be an AP. The common ratio is 3 and the first term is $v_1 = 3$.
b) Therefore, $v_n = 3(n-1) + 3 = 3n$

5) a) $u_n - n^2 = 3n$ then $u_n = n^2 + 3n$
b) $u_{10} = 10^2 - 3 \times 10 = 70$
c) Max will need $S = u_1 + u_2 + \cdots + u_{10}$ matches.

$$S = 1^2 + 3 + 2^2 + 3 \times 2 + \cdots + 10^2 + 3 \times 10 = (1^2 + 2^2 + \cdots + 10^2) + 3(1 + 2 + \cdots + 10)$$
$$= \frac{10(10+1)(2\times10+1)}{6} + 3\,\frac{10(10+1)}{2}$$
$$= \frac{10(10+1)(2\times10+1)}{6} + 3\,\frac{10(10+1)}{2}$$
$$= 550$$

Max will need 550 matches to complete the 10 first steps of his pattern. He will need 3 boxes to do so.
$240 \times 3 - 550 = 170$: 170 matches will remain in the third box.
$u_{11} = 11^2 - 3 \times 11 = 88$: he could make the eleventh step with the remaining matches.
Only 82 will still remain which won't be enough for another row.

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Corrigé n°2

<u>Thème</u> : D3 – Suites – Sequences

1. $u_0 = 12$

$u_1 = u_0 + \frac{50}{100}u_0 = 12 + \frac{12}{2} = 18$

$u_2 = u_1 + \frac{50}{100}u_1 = 18 + \frac{18}{2} = 27$

2.$u_{n+1} = u_n + \frac{50}{100}u_n = u_n + 0.5u_n = 1.5u_n$

3. (u_n) is a geometric progression.

4. (u_n) is a geometric progression.
Its first term is $u_0 = 12$. Its common ration is $r = 1.5$.
$u_n = u_0 \times r^n = 12 \times 1.5^n$

5. $u_4 = 12 \times 1.5^4 = 60.75$

6. **a)** diameter after 1 week? $u_7 = 12 \times 1.5^7 = 205cm$(to 3 s.f.)

b) At this time, $area = \pi R^2 = \pi \times (\frac{205}{2})^2 = 33000cm^2$to 2 s.f.

7. How long would it theoretically take for the water lily to cover a 10 meters wide pond?

10m = 1000cm

$u_{10} \approx 692$ and $u_{11} \approx 1038.$ It would take 11 days.

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Corrigé n°3

Domain 3 Sequences :

1. How many sticks does Anna need to make the 6^{th} row.

Anna needs 19 sticks for the 6th row.

2. Find an expression, in terms of n, for the number of sticks required to make a similar arrangement of n squares in the n^{th} row.

Let a_n be the number of sticks used in row n. It is an arithmetic progression with first term $a_1 = 4$ and common difference $d = 3$

$$a_n = 4 + 3(n-1) = 3n + 1$$

Anna continues to make squares following the same pattern. She makes 4 squares in the 4^{th} row and so on until she has completed 10 rows.

3. Find the total number of sticks Anna needs to make 10 rows.

$$S_{10} = \frac{10}{2}\big(4 + (3 \times 10 + 1)\big) = 175$$

Let k be the number of rows Anna can complete starting with 1750 sticks.

4. Show that k satisfies $3k^2 + 5k - 3500 \leq 0$.
   (*Hint : Write the formula which gives the total number of sticks needed to complete k rows in terms of k*).

$$S_k \leq 1750$$
$$\frac{k}{2}\big(4 + (3 \times k + 1)\big) \leq 1750$$
$$\frac{k}{2}(3k + 5) \leq 1750$$
$$k(3k + 5) - 3500 \leq 0$$
$$3k^2 + 5k - 3500 \leq 0$$

5. Find the value of k.

$$\Delta = 42025$$

$$\sqrt{\Delta} = 205$$

$$k_1 = -35 \quad \text{and} \quad k_2 = \frac{100}{3}$$

k_1 has no sense in the context and $k_2 \approx 33.33$, therefore Anna will have enough sticks to complete 33 rows

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Corrigé n°4

1) **a)** Population double every 25 years. Population grow in average by t% every year.

In 25 years, the population is multiplied by $\left(1+\frac{t}{100}\right)^{25}$.

$$\left(1+\frac{t}{100}\right)^{25}=2 \Leftrightarrow 25\ln\left(1+\frac{t}{100}\right)=\ln(2) \Leftrightarrow \ln\left(1+\frac{t}{100}\right)=\frac{\ln(2)}{25} \Leftrightarrow 1+\frac{t}{100}=e^{\frac{\ln(2)}{25}} \Leftrightarrow t=100\left(e^{\frac{\ln(2)}{25}}-1\right)$$

Therefore $t \approx 2.8$ and the population grow by 2.8% every year in average.

Note: If a candidate only check that $\left(1+\frac{2.8}{100}\right)^{25} \approx 2$, it can be accepted. In particular if the candidate doesn't follow Math in French in Terminale.

b) The product of the land increases every 25 years, by a quantity equal to what it at present produces and, in 1800, agriculture could feed 10 million people.

Therefore, the increase is equal to 10 million after 25 years. It means that each year, the increase is equal to $\frac{10}{25}=0.4$ million.

2) **a)** For any whole number n we have: $p_{n+1}=p_n\times\left(1+\frac{2.8}{100}\right)=1.028\,p_n$. p is a GP with common ratio 1.028 and first term $p_0=10$.

For any whole number n we have: $a_{n+1}=a_n+0.4$. a is an AP with common difference 0.4 and first term $a_0=10$.

b) We have: $p_n=1.028^n\times p_0=10\times 1.028^n$ and $a_n=a_0+0.4n=10+0.4n$.

$1820=1800+20$ means that $n=20$.

$p_{20}=10\times 1.028^{20}\approx 17.4$ million of people in England in 1820.

$a_{20}=10+0.4\times 20=18$ million of people can be fed 1820.

$p_{20}<a_{20}$ therefore the product of the land is enough in 1820.

$p_{30}=10\times 1.028^{30}\approx 22.9$ million of people in England in 1830.

$a_{30}=10+0.4\times 30=22$ million of people can be fed 1830.

$p_{30}>a_{30}$ therefore the product of the land isn't enough in 1830.

c) Using the table of the calculator we get: $p_n<a_n$ for any whole number n up to 25 and $p_{26}>a_{26}$.

It means that, following Malthus theory, there won't be enough food for everyone in England after 26 years.

3) **a)** Curve population follow an exponential increase because of the GP with common ratio 2, whereas the curve food follow a linear evolution because of the AP.

b) This demographic catastrophe didn't happen.

c) No: Malthus lived in the 18's century, before industrial revolution and increase in agricultural production. Then, land has become a less important factor.

+ Now we have ways to limit births….

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Corrigé n°5

1) We add an extra square with four coins, one at each vertex. On each side add 2 more coins. In total, the number of coins added for step 4 is $4 + 4 \times 2 = 12$.

2) From step 1 to step 2, add 4 coins;
From step 2 to step 3, add 8 coins;
From step 3 to step 4, add 12 coins.

3) From step n to step $n + 1$, we add 4 coins, one for each vertex of the new square; and 4 times $n - 1$ coins on each side. The total number of extra coins is $4 + 4(n - 1) = 4n$. (The number of coins you place on each side, without counting the vertices is 2 less than the rank of the step). $c_1 = 1$.

4) a) $u_{n+1} - u_n = 4n - 2(n + 1)^2 + 2n^2 = 4n + 2(2n - 1) = -2$.

b) $u_n = u_1 + (-2)(n - 1) = -2n + 1$.

c) $u_n = c_n - 2n^2$ means $c_n = u_n + 2n^2 = 2n^2 - 2n + 1$.

5) $c_{15} = 421$.

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Corrigé n°6

Domaine D3

1. The (n+1)th month he has doubled the number of followers with respect to the n-th month, so he has $2u_n$ followers,. He lost 1000 followers so we subtract 1 (thousand).
2. $u_0 = 4.$ $u_1 = 7.$ $u_2 = 13.$

   We have $u_1 - u_0 = 3.\ and\ u_2 - u_1 = 6$ so there is no common difference

   We have $u_1/u_0 = 7/4.\ and\ u_2/u_1 = 13/7$ so there is no common ratio

3. a)$v_{\{n+1\}} = u_{\{n+1\}} - 1 = 2u_n - 1 - 1 = 2(u_n - 1) = 2v_n$ so (v_n) is a geometric sequence of common ratio 2.
   b) So $v_n = v_0 q^n$ and $v_0 = u_0 - 1 = 3$ so So $v_n = 3 * 2^n$ and $u_n = v_n + 1 = 3 * 2^n + 1$

4. on the 1st of March 2024 they have around 49 K followers.so yes.

5. A year and a half later they have more than 500 K followers.

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Corrigé n°7

Domain 3: Sequences

1.
   a. $u_1 = 15\,; u_2 = 15 + 3 = 18$
   b. $u_{n+1} = u_n + 3$
      It is an arithmetic progression with common difference 3 and 1^{st} term 15
   c. $u_n = 15 + 3(n - 1) = 12 + 3n$

2. $u_7 = 12 + 3 \times 7 = 33$

3. $u_{30} = 98$ and $u_{31} = 101$
   Maria needs 31 days to reach a hundred boxes a day

1.
   a. $v_1 = 10\,; v_2 = 10 \times 1.1 = 11$
   b. $v_{n+1} = v_n \times 1.1$
      It is a geometric progression with common ratio 1.1 and 1^{st} term 15
   c. $v_n = 10 \times 1.1^{n-1}$

2. $v_7 = 10 \times 1.1^6 \approx 18$

3. $v_{25} \approx 98$ and $v_{26} \approx 108$

4. $u_{23} \approx v_{23}$ with $u_{23} = 81$
   From the 23^{th} day

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Corrigé n°8

1) When you start with one pizza, there is only 1 piece ($n = 0$).

When you cut your pizza with one cut, you get 2 pieces ($n = 1$).

When you add an extra cut, you get 4 pieces ($n = 2$).

When you add the third cut, you maximize the number of pieces if you don't cut through an intersection. The third cut intersects the two previous lines and creates 3 new pieces.

So you get 7 pieces in total. $u_3 = 7$.

When you add the fourth cut, you maximize the number of pieces if you don't cut through an intersection. The fourth cut intersects the three previous lines and creates 4 new pieces. So you get 11 pieces in total. $u_4 = 11$.

2)

n	0	1	2	3	4	5
u_n	1	2	4	7	11	16
First differences $v_n = u_n - u_{n-1}$ ($n \geq 1$)		1	2	3	4	5
Second differences w_n		1	1	1	1	1
S_n		1	3	6	10	15

3) v is an arithmetic sequence with common difference 1.

4) When you add the n-th cut, you maximize the number of pieces if you don't cut through an intersection. The n-th cut intersects the $n-1$ previous lines, passes through n regions and creates n new pieces. If you cunt through an intersection, you lose some regions.

5) $S_n = 1 + 2 + 3 + \cdots + n = \frac{n(n+1)}{2}$.

6) $S_n = v_1 + v_2 + \cdots + v_n = (u_1 - u_0) + (u_2 - u_1) + \cdots + (u_n - u_{n-1}) = u_n - u_0 = u_n - 1$.

So $u_n = \frac{n(n+1)}{2} + 1$.

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Corrigé D3 - n°9

SEQUENCES

Exercise 1 : **Aunt Lucy's Legacy**

This morning, Lucy received that letter of her Aunt Lucy.

Dear Lindsay,

Now that I am getting on (I turn 70 today) I want to give you some of my money. I shall give you a sum each year, starting now. You can choose which of the following schemes you would like to use.

1. £50 now, £60 next year, £70 the year after and so on.
2. £10 now, one and a half as much next year, one and a half as much again the year after and so on.

Of course, the scheme can only operate while I am alive. I look forward to hearing which scheme you choose and why.

Love,

Aunt Lucy

From Website Maths Map, https://www.transum.org/Software/Investigations/Aunt_Lucy.asp

Help her to do the best choice.

We have to consider each choice separately.

<u>Case 1</u>: it is a sequence in arithmetic progression:

$\begin{cases} u_0 = 50 \\ u_{n+1} = u_n + 10 \end{cases}$ so $u_n = 50 + 10n$

So the amount she can hope after n years is $S1 = n \times \frac{100+(n-1)\times 10}{2}$

<u>Case 2</u>: it is a sequence in geometric progression:

$\begin{cases} v_0 = 10 \\ v_{n+1} = 1{,}5v_n \end{cases}$ so $v_n = 10 \times 1{,}5^n$

So the amount she can hope after n years is $S2 = 10 \times \frac{1-1{,}5^n}{1-1{,}5}$

We have to compare the sum of the amount.

n	un	Sum un	vn	Sum vn
0	50	50	10,00	10,00
1	60	110	15,00	25,00
2	70	180	22,50	47,50
3	80	260	33,75	81,25
4	90	350	50,63	131,88
5	100	450	75,94	207,81
6	110	560	113,91	321,72
7	120	680	170,86	492,58
8	130	810	256,29	748,87
9	140	950	384,43	1133,30
10	150	1100	576,65	1709,95
11	160	1260	864,98	2574,93
12	170	1430	1297,46	3872,39
13	180	1610	1946,20	5818,59
14	190	1800	2919,29	8737,88
15	200	2000	4378,94	13116,82
16	210	2210	6568,41	19685,23
17	220	2430	9852,61	29537,84
18	230	2660	14778,92	44316,76

If Aunt Lucy lives less than 9 years, the first option is the best but if she lives 9 years and more, the second will be more interesting. According to the life expectancy in GB, the second choice seems to be the best.

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Corrigé n°1

Topic:The British monarchy itself is one of the longest established monarchies in the world, and the Queen is believed to be related by blood or by marriage to every English king or queen since at least the 13th century.

The length of reign of each of the **last 19 monarchs** is given in the table.

George VI	16 years	**George IV**	10 years	**James II**	3 years
Edward VIII	0 year	**George III**	60 years	**Charles II**	25 years
George V	26 years	**George II**	33 years	**Charles I**	24 years
EdwardVII	9 years	**George I**	13 years	**James I**	22 years
Victoria	64 years	**Anne**	12 years	**Elizabeth I**	45 years
William IV	7 years	**William III**	14 years	**Mary**	5 years
				Edward VI	6 years

1) Order the data set from the lowest to the greatest value. (You can represent the data in an ordered stem and leaf diagram).

0 – 3 – 5 – 6 – 7 – 9 – 10 – 12 – 13 – 14 – 16 – 22 – 24 – 25 – 26 – 33 – 45 – 60 – 64

2) Find the median and quartiles of the length of reign of these 19 monarchs.
You **must** show calculations to support your answer.

19 is an odd number.There is a middle number.When the data points are ordered from the lowest to the greatest value, the median is the 10 th value.**The median is 14.**
Q_1**= 7 (the 5 th value)**
Q_3**= 26 (the 15 th value)**

3) Calculate the range and the interquartile range.

64 – 0 = 64 **The range is equal to 64 years**

Q_3- Q_1= 26 – 7 = 19 . **The interquartile range equals 19 years.**

4) Write down the name of any monarch whose length of reign is an **outlier.**

A box plot is constructed by drawing a box between the upper and lower quartiles with a solid line drawn across the box to locate the median. The following quantities (called *fences*) are needed to identify extreme values in the tails of the distribution:

1. lower inner fence: Q1 - 1.5*IQ
2. upper inner fence: Q3 + 1.5*IQ

A point beyond an inner fence on either side is considered a mild outlier. A point beyond an outer fence is considered an extreme outlier.

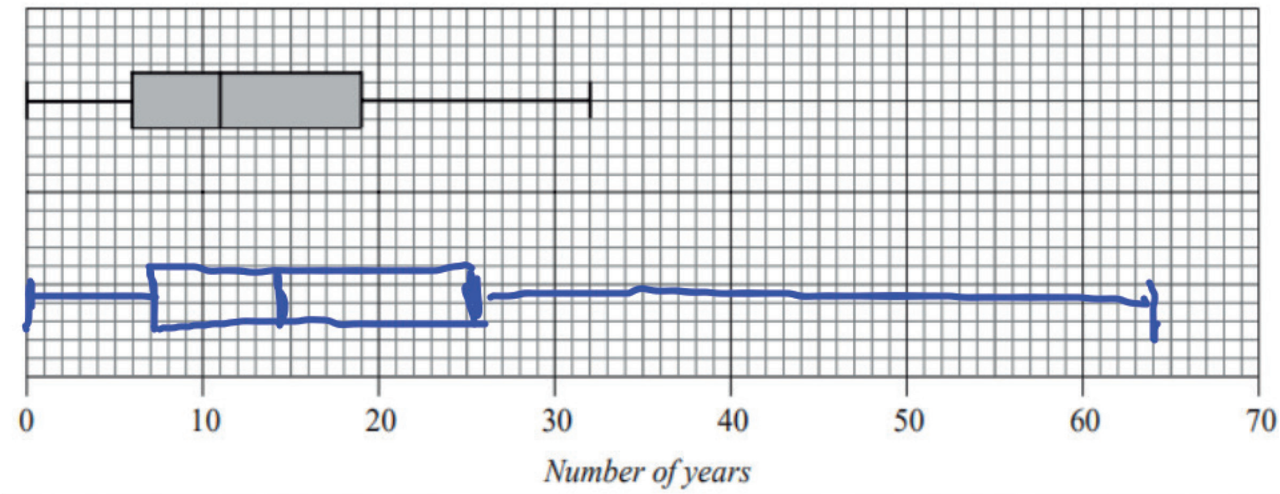
Q1 – 1.5*IQ=7-28,5 <0

Q3 + 1.5*IQ=26+28,5= 54,5

The **names of any monarch whose length of reign is an outlie**r are **George III** and **Victoria**

5) The box and whisker plot shows the length of reign of the last 19 popes.

Draw a box and whisker plot for the length of reign of the last 19 monarchs on a copy of the
diagram.



5) Are the statements true or false ?Explain your reasoning.

Statement 1 : 25 % of the reigns of the last 19 popes are greater than 19 years

It is true because Q_3= 19

Statement 2: 50 % of the reigns of the last 19 popes are less than 11 years
It is true because Q_1= 11

Statement 3 : 20 % of the reigns of the last 19 monarchs are greater than 20 years
It is false because $\frac{8}{19}$> 20 %

6) Compare the length of reign of monarchs ans popes.

In the box plot for lenght of reign of the last 19 popes , the median (the vertical line inside the box) is slightly above 11 years , whereas the median for the lenght of reign of the last 19 monarchs is 14 years.

	Length of reign of the last 19 monarchs	Length of reign of the last 19 popes
Lowest value	0	0
Q_1	7	6
Median	14	11
Q_3	26	19
Greatest value	64	32
Range	64	32
Interquartile range	19	13

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Corrigé n°2

STATISTICS / D4

Keys for solution

1) The values for the five numbers are :

Minimum	First Quartile	Median	Third Quartile	Maximum
45	65	74	83	113

2) Range : 113 – 45 = 68
IQR
Q_3-Q_1= 83-65 = 18
3) The values for the five numbers are :

Minimum	First Quartile	Median	Third Quartile	Maximum
45	65	74	83	113

4) $Q_1 - 1.5(IQR) = (65 - 1.5 \times 18) = 38$ $Q_3 + 1.5(IQR) = (83 + 1.5 \times 18) = 110$

111,113

5) True-True-False
6) Data scientists and sports statisticians — if they are well-trained experts — can tease out possible correlations and likelihoods based on copious amounts of data, e.g., the athlete's current and future health (physical, mental, and emotional), individual vs. team dynamics, game simulation in various conditions, etc.

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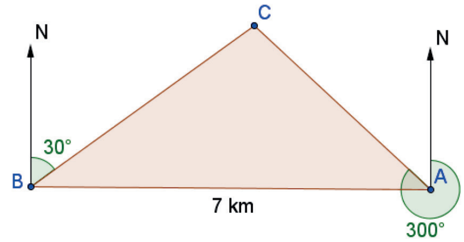
Corrigé n°1



1) Work out the measures of angles $\angle A$, $\angle B$ and $\angle C$ in the ABC triangle.

$\angle A = 90° - (360° - 300°)$ $\angle A = 30°$

$\angle B = 90° - 30°$ $\angle B = 60°$

$\angle C = 180° - (30° + 60°)$ $\angle C = 90°$

2) What can you say about triangle ABC ? This is a right-angled triangle.

3) Work out the bearing of Tower B from Tower A . 270°

4) Calculate the distance between Tower B and the fire using the sine rule.

$$\frac{a}{\sin \angle A} = \frac{b}{\sin \angle B} = \frac{c}{\sin(\angle C)}$$

$$\frac{a}{(\sin 30°)} = \frac{7}{(\sin 90°)}$$

$$\boxed{a = \frac{7 \times \left(\frac{1}{2}\right)}{1} = 3.5}$$

5) Calculate the distance between A and C. Round to 2 dp.

Pythagoras theorem $AB^2 = BC^2 + CA^2$ then $AC \approx 6.06$

6) A fire-fighting plane can fly from tower A to the fire at a speed of $303\ km.h^{-1}$.
A fire truck can go from tower B to the fire at a speed of $70\ km.h^{-1}$.
Which vehicle will reach the fire first?

Fire truck :	Plane :
$v = \frac{d}{t}$ then $t = \frac{d}{v} = \frac{3.5}{70} = 0.05h = 3\ minutes$	$v = \frac{d}{t}$ then $t = \frac{d}{v} = \frac{6.06}{303} = 0.02h = 72\ s$

The plane will reach the fire first.

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Corrigé n°2

Domaine D5 : Advanced geometry

1) **A)** 113°
   b) 293°
   c) $\sqrt{58}$ = 8 to the nearest whole number

2) **A)** do it yourself ! ☺
   b) 245°
   c) angle ABC = 68° then using the cosine rule, AC =128.6 km to 1dp
   d) using the sine rule, angle ACB=35° and the bearing of A from C is equal to 210°

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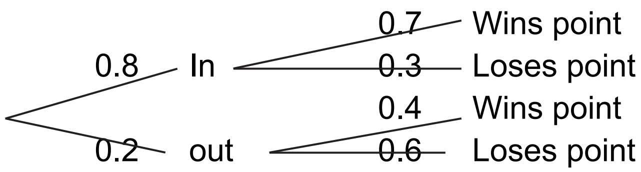
D7-sujet n°2 -Corrigé

Answer:

1)a)

First serve



1)b) P(wins point)=P(wins point and first serves in) + P(wins point and first serves out)
=0.8*0.7+0.2*0.4=0.64

1)c) P(first serve out |wins)=$\frac{P(first\ serves\ out\ and\ wins)}{P(wins)} = \frac{0.2*0.4}{0.64} \approx 0.125$

2) a)and b) a trial = a point
Success = he wins

P(success)=0.57

We repeat 60 times the same trial independently

Let label X the random variable which gives the number of successes, X follows the binomial distribution with parameters 60 and 0.57

$$P(X = 40) = \binom{60}{40} * 0.57^{40} * 0.43^{20} \approx 0.03$$

2)c) E(X)=60*0.57≈34

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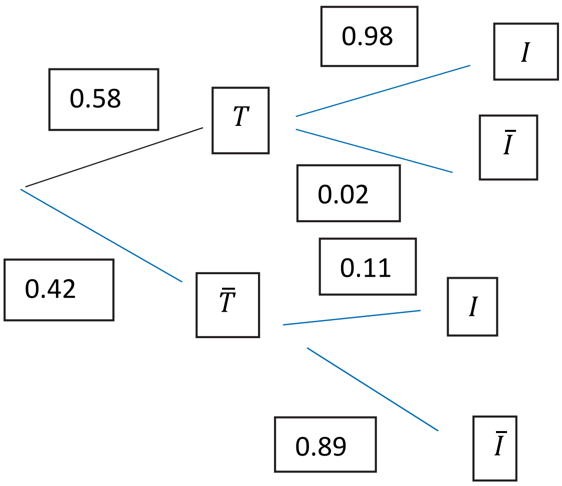
D7-sujet n°4 - corrigé

1.



2. a. $P(T \cap I) = 0.58 \times 0.98 = 0.5684$

b. $P(T \cap \bar{I}) = 0.42 \times 0.11 = 0.0462$

c. $P(T) = 0.5684 + 0.0462 = 0.6146$

3. specificity: $P_I\ (T) = \frac{P(I \cap T)}{P(T)} = \frac{0.5684}{0.6146} \cong 0.92$ to 2 d.p.

Sensitivity : $P_{\bar{I}}\ (\bar{T}) = \frac{P(\bar{I} \cap \bar{T})}{P(\bar{T})} = \frac{0.42 \times 0.89}{1 - 0.6146} \cong 0.97$ to 2 d.p.

4.The test doesn't meet the criteria because the specificity is not high enough.

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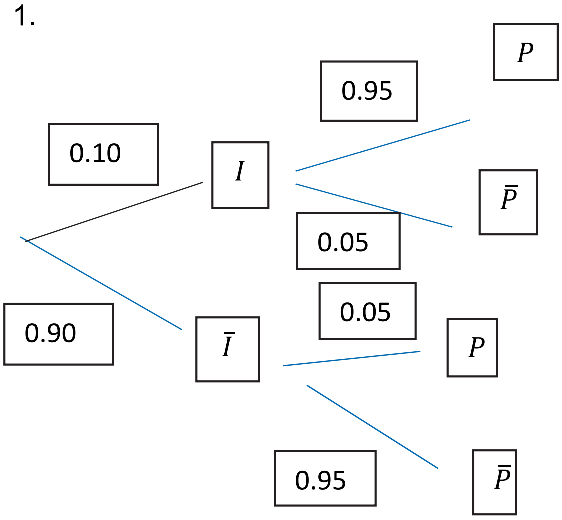
D7-Sujet n°5 -Correction :

1.



$P(P \cap I) = 0.10 \times 0.95 = 0.095$

$P(P \cap \bar{I}) = 0.9 \times 0.05 = 0.045$

$P(P) = 0.095 + 0.045 = 0.14$

$P_P(I) = \frac{P(I \cap P)}{P(P)} = \frac{0.095}{0.14} \cong 0.68$ to 2 d.p.

2.a. $P_P(I) = \frac{P(I \cap P)}{P(P)} = \frac{x \times 0.95}{0.95 \times x + (1-x) \times 0.05} = \frac{x \times 0.95}{0.95 \times x + 0.05 - 0.05 \times x} = \frac{0.95x}{0.9x + 0.05}$

b. We solve the inequality for x : $\frac{0.95x}{0.9x+0.05} \geq 0.95$

$0.95x \geq 0.95 \times (0.9x + 0.05)$

$x \geq 0.9x + 0.05$

$0.1x \geq 0.05$

$x \geq \frac{050}{0.1}$

$x \geq 0.5$ The probability to be infected given that your test is positive is at least 95% if the prevalence of the disease in the population has to be greater than 50%.

3.a. X, the number of students tested positive on a chosen day, follows a binomial distribution with $n = 35$ and $p = 0.14$.

b. $P(X \geq 7) = 1 - P(X < 7) = 1 - P(X \leq 6) \approx 0.21$ to 2dp

$c.\ E(X) = 0.14 \times 35 = 4.9$

On average, if you consider a large number of classes with 35 students, you'll have, on a chosen day, approximatively 4.9 students tested positive.

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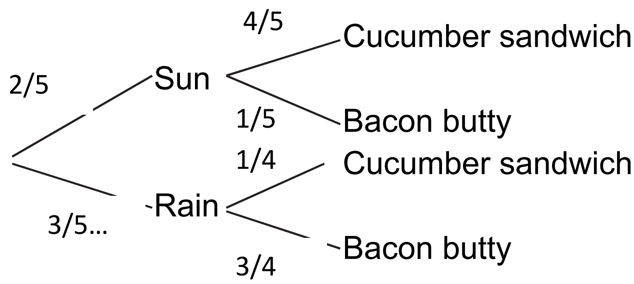
D 7- sujet n°6 Corrigé:

1) A tree diagram



2) 1/5

3) P(S and BB)=2/5 * 1/5 = 2/25

4) You apply the law of total probabilities:

   P(BB)=P(S and BB) + P(R and BB)= 2/5*1/5+3/5*3/4=2/25+9/20=0.53

5) P(BB)=0.53; P(S)=2/5=0.4 but P(BB and S)=2/25=0.08

   As 0.4*0.53=0.212 different from 0.08 , they are not independent.

6) An event: the choice of a soda

   The success: the choice of a fizzy drink

   Proba of the success: 0.7

   Number of trials: 31

   The random variable X that gives the number of successes follows the binomial distribution with parameters 31 and 0.7

   Then P(X=20)=(31 choose 20)*0.7^{20}*0.3^{11}=0.12 (roughly)

7) Expectation = n*p=31*0.7=21.7 so 22 fizzy drinks