Mathématiques SANS Frontières

Discovery questions

Even partial solutions and attempts can get marks.

Neat and careful work is important.

Hand in only one team answer sheet for each question.

Question 1: Funny hat! (7 marks)

Give your answer in French, German, Spanish or Italian using a minimum of 30 words.

Trois clowns, Anatole, Michel et Thomas, ont déposé trois chapeaux rouges et deux chapeaux verts dans leur loge. Avant d'entrer en scène, ils doivent récupérer chacun un chapeau.
Les clowns ne trouvent pas l'interrupteur et la loge est plongée dans le noir. Chacun prend un chapeau au hasard et le pose sur sa tête. Ils sortent de la loge et entrent en scène.
On demande à chaque clown s'il est capable de deviner la couleur de son chapeau.
Anatole regarde les deux autres et dit « Non ».
Puis Michel regarde les deux autres et dit « Non ».
Enfin Thomas, qui est aveugle, répond « Oui ».

Expliquer comment ce clown aveugle a pu déterminer la couleur de son chapeau. Quelle est-elle ?

Drei Clowns, Anatole, Michel und Thomas, haben drei rote Hüte und zwei grüne Hüte in ihrer Garderobe.
Vor ihrem Auftritt muss jeder der drei Clowns einen Hut holen.
Die Clowns finden den Lichtschalter nicht und in der Garderobe ist es dunkel. Jeder nimmt zufällig einen Hut und setzt ihn auf. Sie gehen aus der Garderobe hinaus und treten auf.
Jeder Clown wird gefragt, ob er in der Lage ist, die Farbe seines Hutes zu erraten.
Anatole schaut die beiden anderen an und sagt: „Nein".
Dann schaut Michel die beiden anderen an und sagt: „Nein".
Zuletzt antwortet Thomas, der blind ist: „Ja".

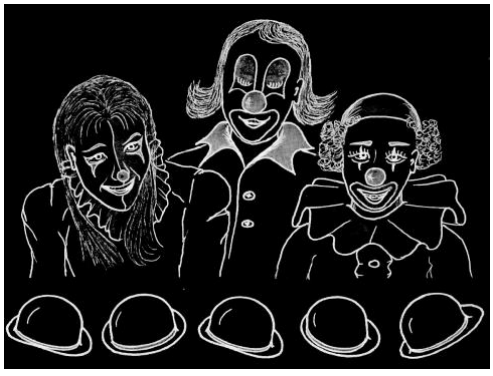
Erklärt, wie der blinde Clown die Farbe seines Hutes bestimmen konnte. Welche Farbe hat sein Hut?

Tres payasos, Anatole, Michel y Thomas, han dejado tres sombreros rojos y dos sombreros verdes en el camerino.
Antes de salir a escena, tienen que coger un sombrero cada uno.
Los payasos no encuentran el interruptor y el camerino está a oscuras. Cada uno coge un sombrero al azar y se lo pone en la cabeza. Salen del camerino y entran en escena.
Preguntamos a cada payaso si es capaz de adivinar el color de su sombrero.
Anatole mira los otros dos y dice "No".
Luego Michel mira los otros dos y dice "No".
Por fin Thomas, que es ciego, dice "Si".

Explica cómo el payaso ciego ha podido adivinar el color de su sombrero. ¿Cuál es?

Tre clown, Anatole, Michele e Tommaso hanno depositato in camerino tre cappelli rossi e due verdi. Prima di entrare in scena ognuno di loro deve recuperare un cappello.
I clown non trovano l'interruttore e il camerino è completamente al buio.
Tutti prendono un cappello a caso, se lo mettono, poi, escono dal camerino ed entrano sul palcoscenico.
Alla domanda se sono in grado d'indovinare il colore del proprio cappello,
Anatole guarda gli altri due e dichiara : « No ».
Michele, a sua volta, guarda gli altri due e dichiara : « No ».
Tommaso, infine, che è cieco risponde : « Sì ».

Spiegate come il clown cieco abbia potuto determinare il colore del suo cappello. Qual è?

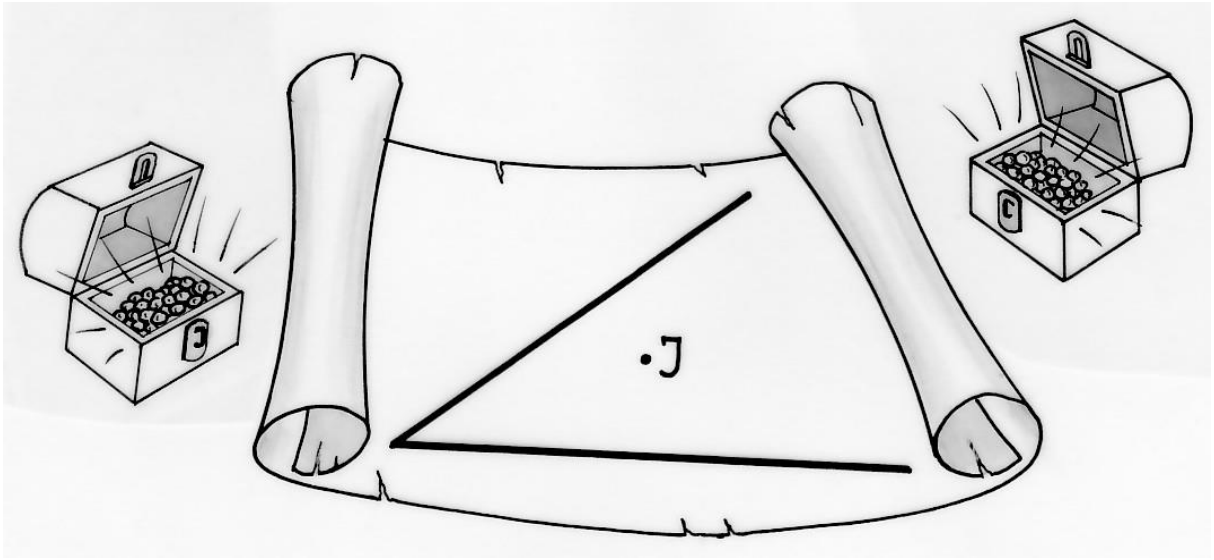


Question 2: By Jove
(5 marks)

A treasure was split in two halves and each half was buried somewhere in a street. It is known that the statue of Jupiter, the ancient Roman god, lies equidistant from the two hidden treasures. Each line segment on the map shown represents the streets with the hidden treasures and, the point J represents the location of the statue of Jupiter.

Create a geometrical figure that shows the possible locations of the two hiding places.

Explain.



Question 3: Rolling Raoul (7 marks)

Raoul draws the following diagrams using a spirograph.
For the first diagram, he creates a large circle of radius 32cm. Within this circle he rotates a disc of radius 8cm without sliding and always in contact with the large circle.

A pen is attached to the perimeter of the small disc and leaves a trace.

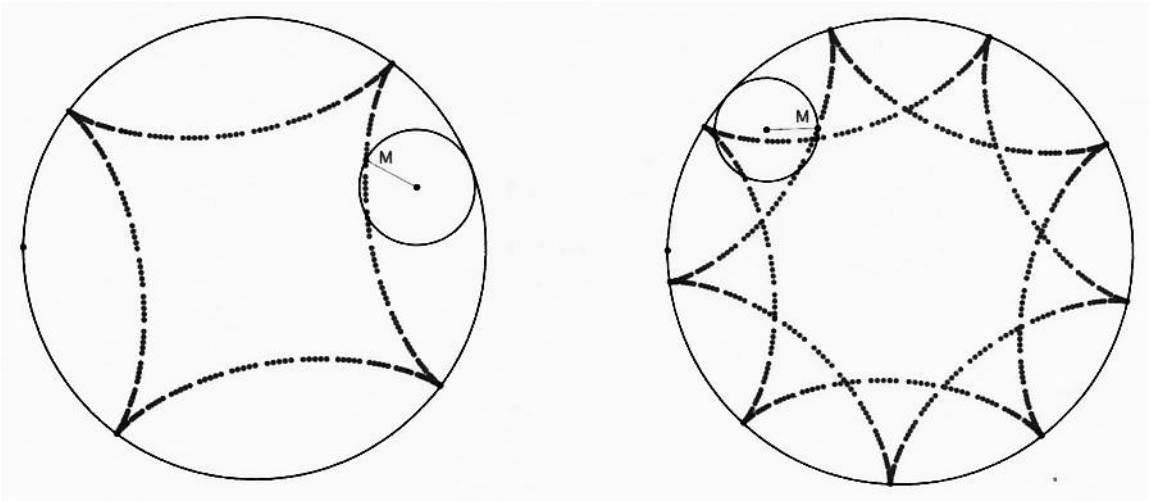
The small disc rotates until the pen returns to the start of the trace.

For the complete trace, the pen is in contact with the large circle at four different points.

For the second diagram, Raoul uses a large circle of radius 36cm and a disc of radius 8cm. This time, the pen is in contact with the large circle at nine different points.

Obtain the number of points of contact if Raoul uses a circle of 30cm and a disc of 9cm.

Explain your answer.



Question 4: Good flats (5 marks)

In my building, the flats (apartments) are numbered 1, 2, 3 … starting from the first floor, where each number is used once. Each floor has the same number of flats.

I live on the fifth floor of the building in flat number 65.

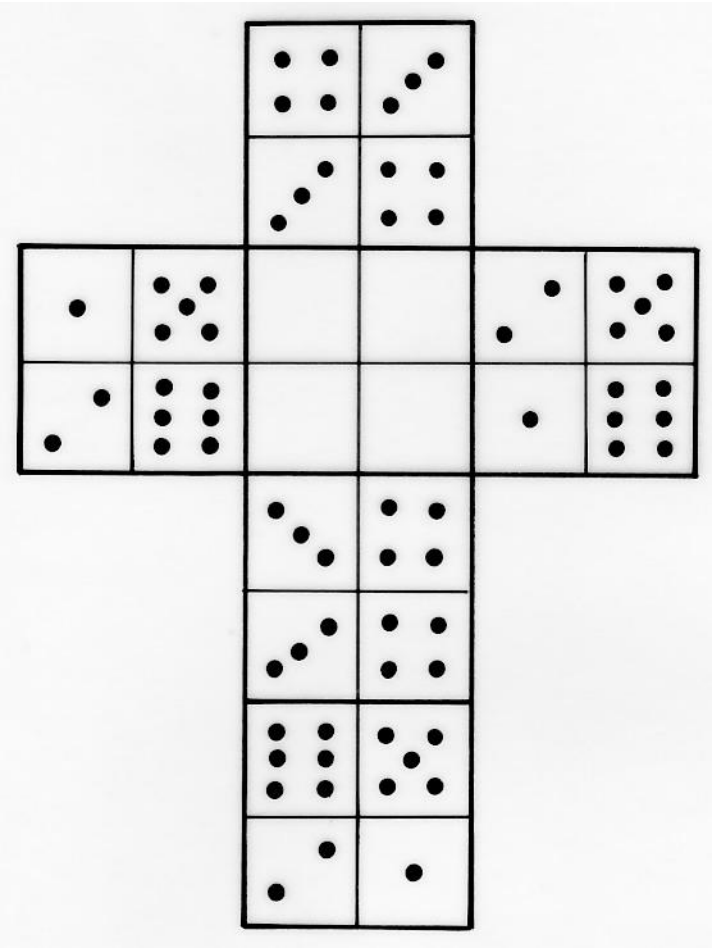
How many flats could there be on each floor? Give all solutions.

Question 5: Net addition (7 marks)

The sum of the dots of two opposite sides of a die is always equal to 7.
Eight identical dice are combined to form a big cube. Part of the net of the big cube is shown below.

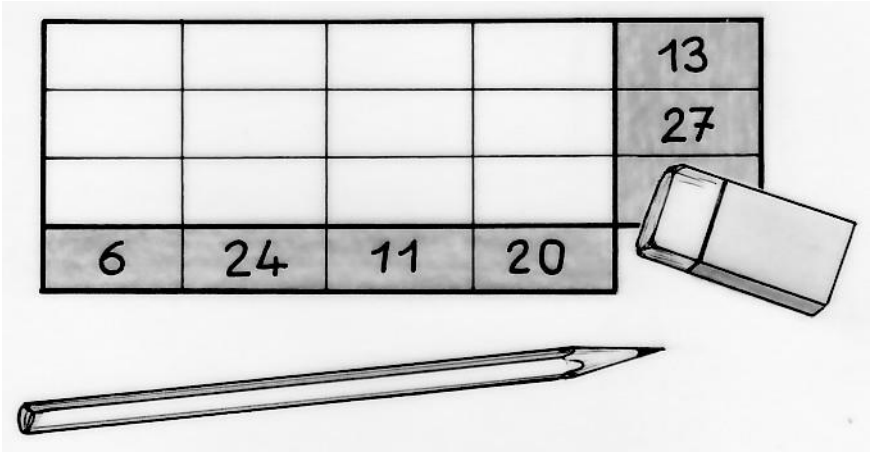
The sum of the dots on each face of this big cube is always equal to 14.

Copy and complete the diagram below to show the net of the big cube.



Question 6: Spot the gaps (5 marks)

The grid below shows the sum of each row and column in the greyed-out cells. To complete the grid, you are only permitted to use the numbers 1 to 9. Each number can only appear once in each column and each row.

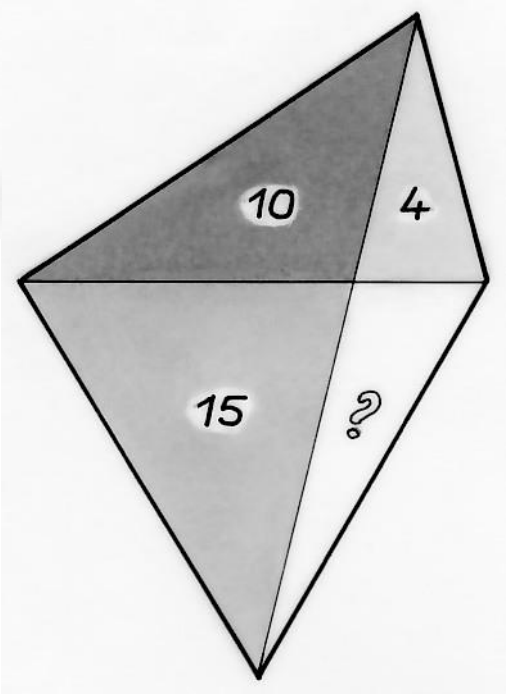


Complete the grid.

Question 7: Take to the skies (7 marks)

The quadrilateral shown is split by its diagonals into four triangles. The area, in square centimetres, of three of the triangles is shown in the picture.

Calculate the total area of the quadrilateral. Justify your answer.



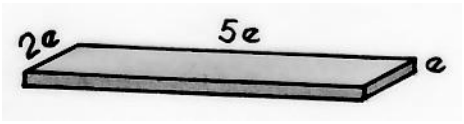
Question 8: Boxed in!
(5 marks)

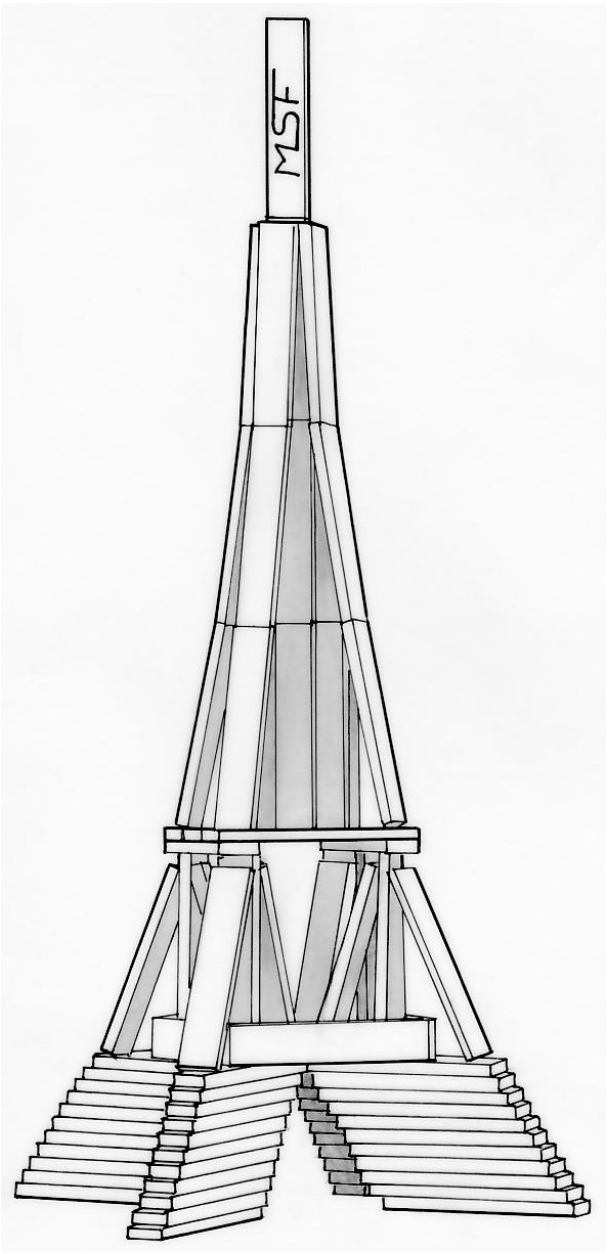
A construction game uses identical rectangular planks. The length of each plank is 5 times the height and the breadth is twice the height.

A box is completely filled with 48 planks with no empty space. The interior dimensions of this box are 8cm by 16cm by 30cm.

Calculate the dimensions of a single plank.

Provide two possible arrangements of the 48 planks in this box.





Question 9: Born in the '90s (7 marks)

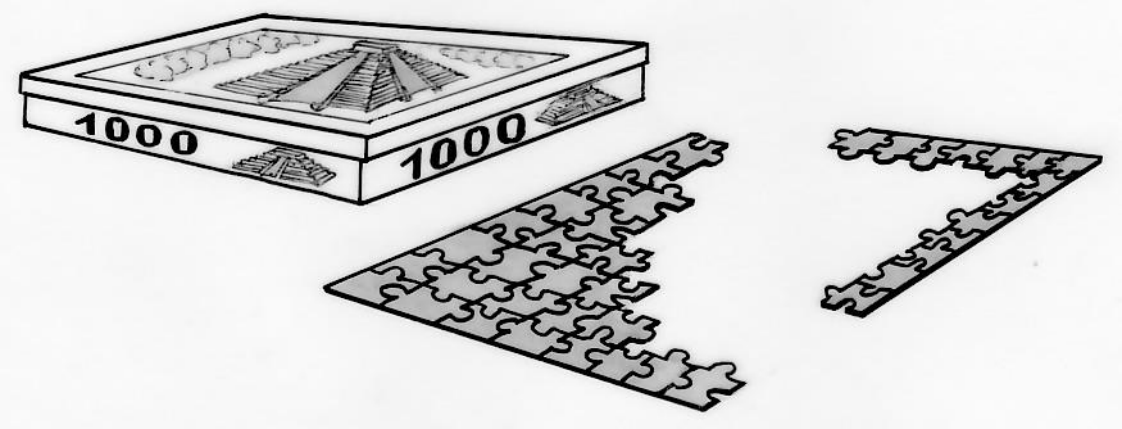
Emile wants to do a puzzle. The lid of the puzzle box has “1000 pieces” written on it.

The puzzle boundary is made up of uneven lines which go roughly in two perpendicular directions and could be considered as a grid.

Emile starts by collecting all the pieces of the boundary. He finds exactly 124 pieces which include all 4 corners.

As he attempts to put the puzzle together, Emile suddenly realises that it is impossible for this puzzle to have 1000 pieces.

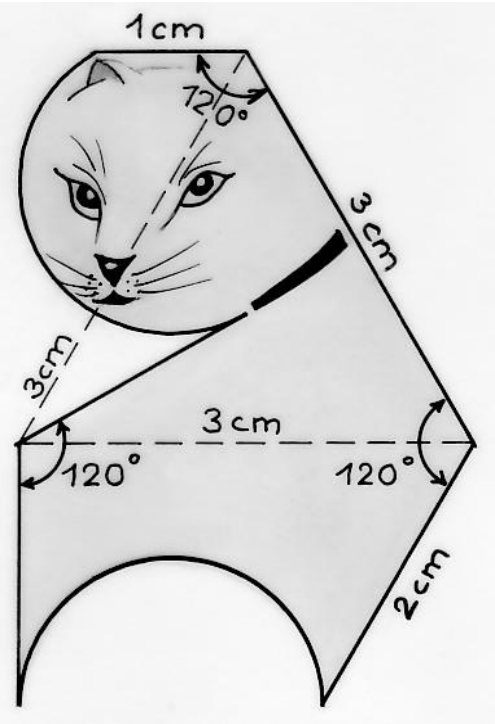
What could be the actual number of pieces of this puzzle, knowing that it is close to 1000? Justify your answer.



Question 10: Cat mosaic (10 marks)

A toymaker is selling a game that is made of 60 identical pieces which together form a mosaic. The pieces are flat and stacked on top of each other in a box, forming an upright structure of 5cm breadth and 6cm length. Each piece has a thickness of 5mm.

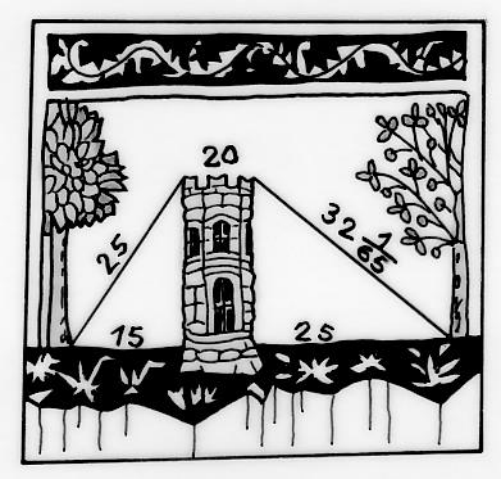
A single piece is shown in the picture below.



Draw the first layer of the box and calculate the minimum length of the box.

Question 11: Splitting hairs
Senior classes only (5 marks)

The picture below shows an extract from the document "Lo Compendion Del Abaco", written in the Occitan language by Frances Pelos in 1492.



Camille and David, neither of whom have a calculator, are trying to understand the value $32\frac{1}{65}$ proposed by Frances Pelos.

Camille says: "It's easy. I know how to calculate the length of the hypotenuse in a right-angled triangle. David replies "$32^2 = 1024$ and $33^2 = 1089$. We just need to go from 1024 to 1025."

Justify Camille's statement and complete the method started by David to obtain $32\frac{1}{65}$**.**

Note that $32\frac{1}{65}$ means $32 + \frac{1}{65}$.

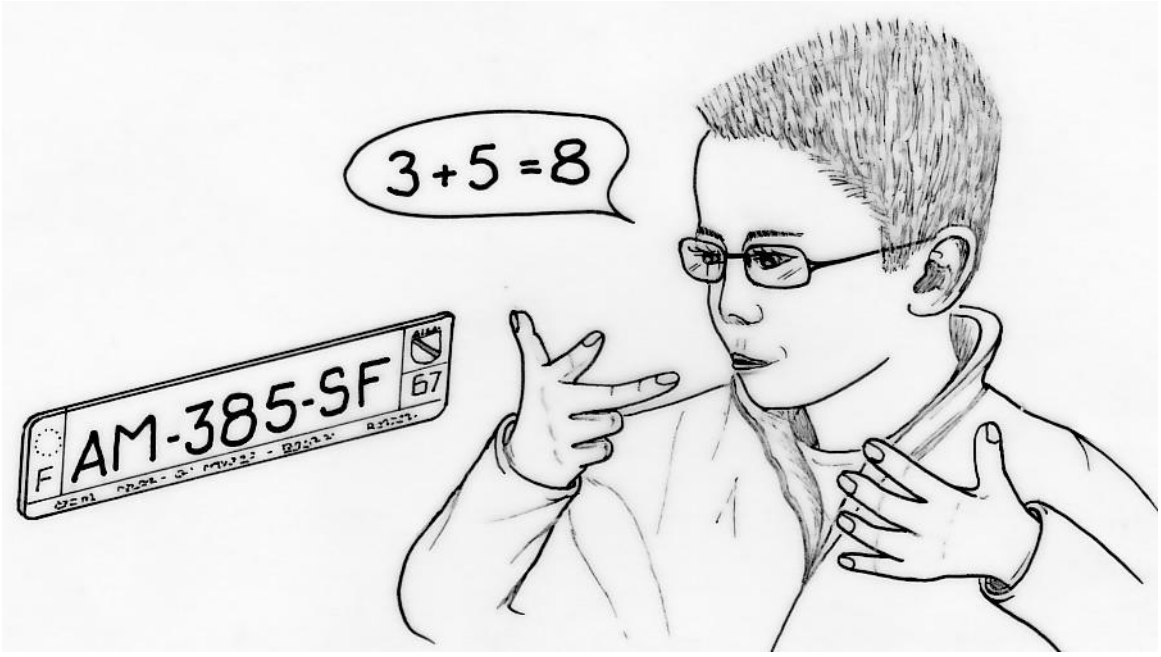
Question 12: Ride along!
Senior classes only (7 marks)

In France, car registration numbers are created using 2 letters, 3 numbers and then 2 letters such as “AB 038 CD”. The number sequence “000” is not used.

On a long trip, Papy keeps his kids occupied by playing a game that uses the 3 numbers on the number plate of the car in front of them.

If the 3 numbers are consecutive numbers, even in the wrong order, Romane scores a point. If the sum of the first and third numbers equals the middle number, Timothy scores a point.

Which of the kids is more likely to win? Justify your answer.



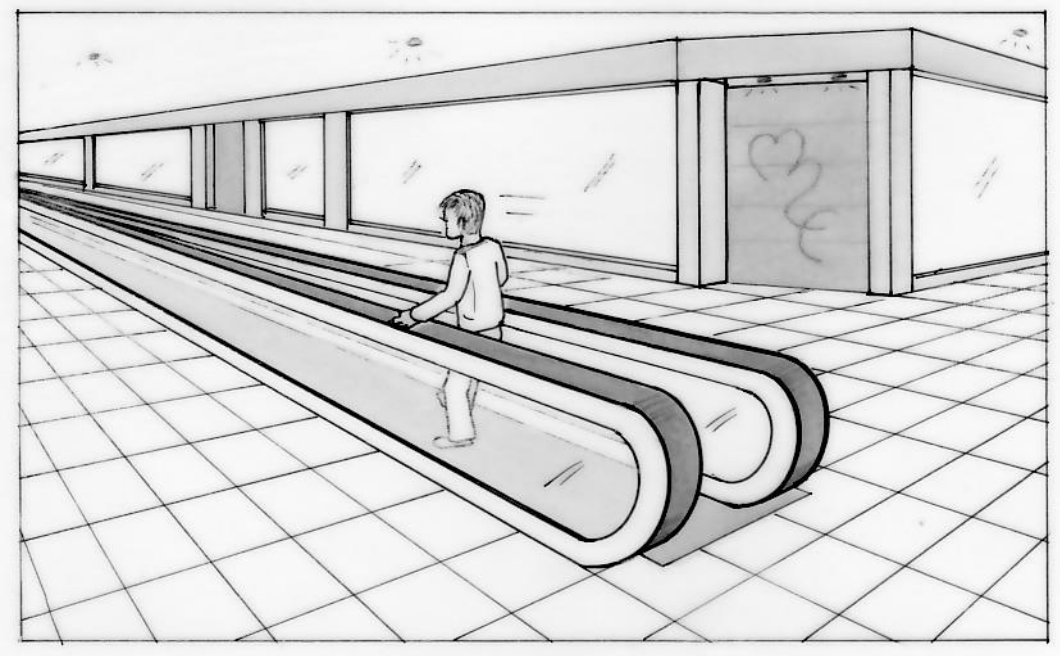
Question 13: On foot
Senior classes only (10 marks)

Victor uses a moving walkway to gain time while going through a shopping centre. While on the moving walkway, he walks at his normal pace. It takes him 1 minute and 12 seconds to get from one end of the moving walkway to the other.

One day, he gets on the moving walkway at the wrong end, against its direction of movement. Walking again at his normal pace, it takes him 6 minutes to get from one end of the moving walkway to the other.

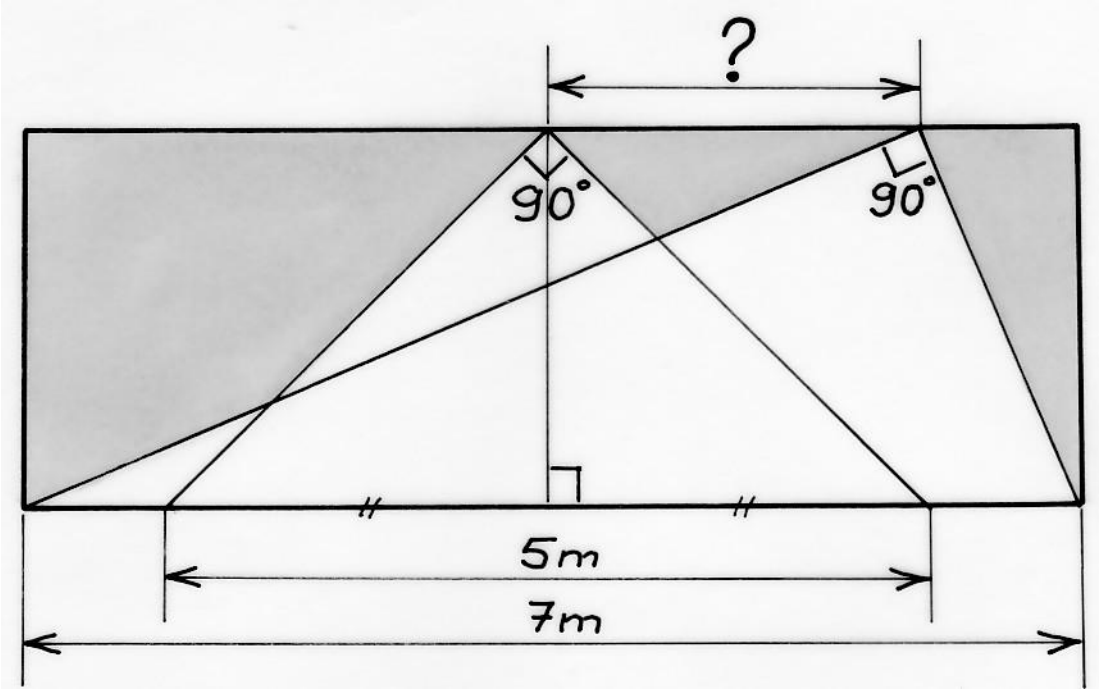
The next day, the moving walkway is out of order.

How long would it take Victor to get from one end of the moving walkway to the other on this day, walking at his normal pace? Justify your answer.



Question 13 Pro: Light bulb moment! Senior classes only (10 marks)

Sabine wants to add lighting to a 7m long room in her basement. She would like to install two spotlights, each of which has a lighting range of 90° as shown in the sketch.



She installs the first spotlight in the ceiling at the centre of the room, and places it so that it lights the centre of the room covering a range of 5m.

The second spotlight is also installed on the ceiling, but must be placed so that it lights the whole length of the room without lighting the walls.

Sabine wants to know the distance between the two spotlights. She recalls a phrase she heard at school that "a right-angled triangle is half of a rectangle."

Calculate the distance between the two spot lights. You may use a geometrical picture to help you answer the question.