Question 1 : Chronomèche
(7 marks)

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

Der Burgwächter muss die Tore der Burg in genau 6 Stunden öffnen. Um die Zeit zu messen, verfügt er über 3 Kerzen: Die große schmilzt in 4 Stunden, die mittlere in 3 Stunden und die kleine in einer Stunde. Man kann nicht genau abmessen, wann eine Kerze sich um die Hälfte, um ein Drittel, um ein Viertel verkleinert hat …

**Wie muss der Burgwächter vorgehen?**

El guardián del castillo tiene que abrir las puertas dentro de 6 horas exactamente. Para medir el tiempo, dispone de 3 velas: la grande se derrite en 4 horas, la mediana en 3 horas y la pequeña en 1 hora. Es imposible saber cuando una vela se ha derretido por la mitad, la tercera parte, la cuarta parte….

¿Como tiene que proceder el guardián?

Le garde du château doit ouvrir les portes dans exactement 6 heures. Pour mesurer le temps, il dispose de 3 bougies : la grande fond en 4 heures, la moyenne en 3 heures et la petite en 1 heure. Il n'est pas possible de repérer précisément quand une bougie s'est réduite de moitié, du tiers, du quart ...

Comment le garde doit-il s'y prendre ?

La guardia del castello deve aprire le porte esattamente tra 6 ore. Per misurare il tempo ha a disposizione 3 candele: la grande si consuma in 4 ore, la media in 3 ore e la piccola in un'ora.
Non è possibile individuare esattamente quando una candela si è ridotta della metà, di un terzo, di un quarto….

Come deve organizzarsi la guardia?
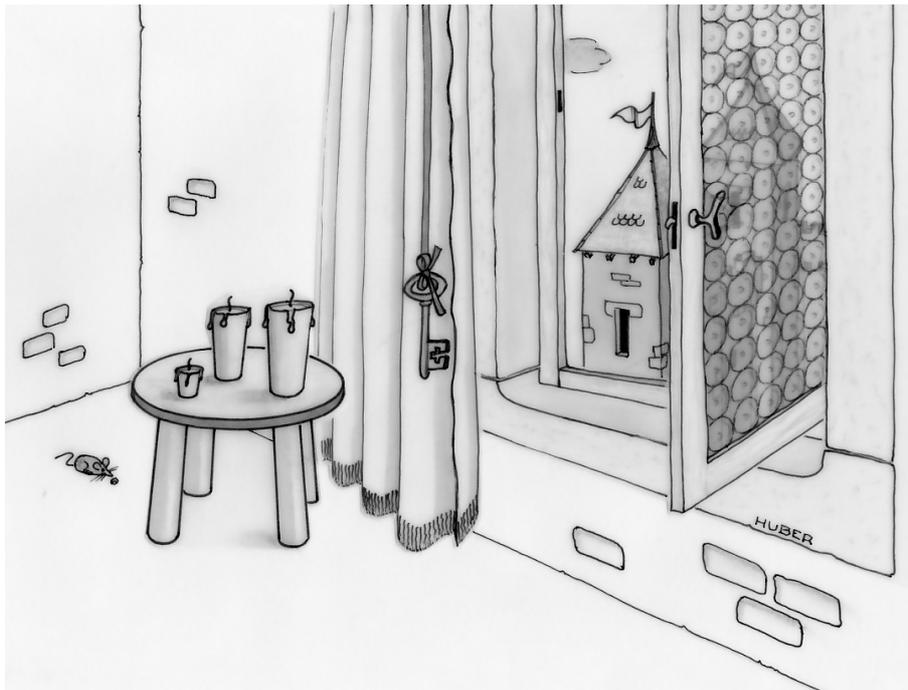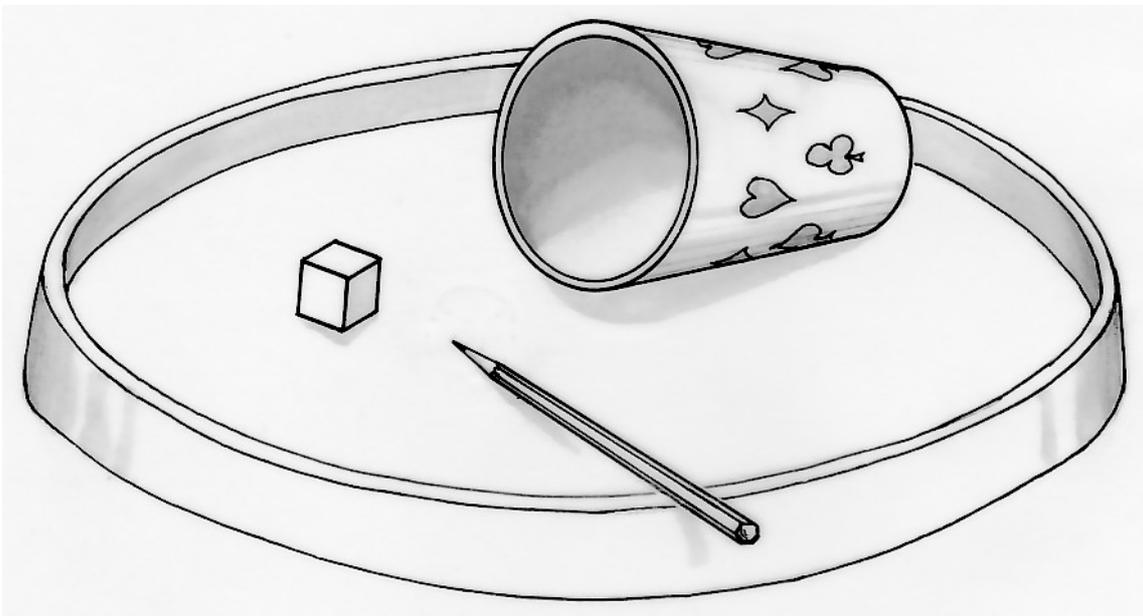
Question 2: Dai's die
(5 marks)

On the normal traditional die, the sum of numbers on the opposite faces is always 7.
Dai wants to make an unusual die.
The six faces will have the numbers 1 to 6.
The three sums of the opposite faces are three consecutive numbers.

Find two possible versions of the unusual die and draw a net for each one.

Note: *The plural of die is dice. Most people use dice as a singular though. The Welsh name Dai is pronounced - die.*

Question 3: Sheriff's star
(7 marks)

Here is a method that produces a paper version of a sheriff's star:
You start by drawing a regular pentagon inside a circle of radius 10 cm.
Inside the pentagon, you draw a five-pointed star as shown in the diagram.
Cut out the pentagon.
Fold the pentagon several times and find the single straight-line scissors cut that produces the well-known five-pointed star when you unfold the paper.
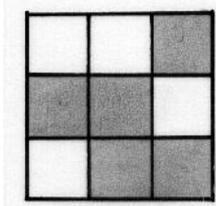
Show your teacher how you can get the star with just one scissors cut of your folded paper.
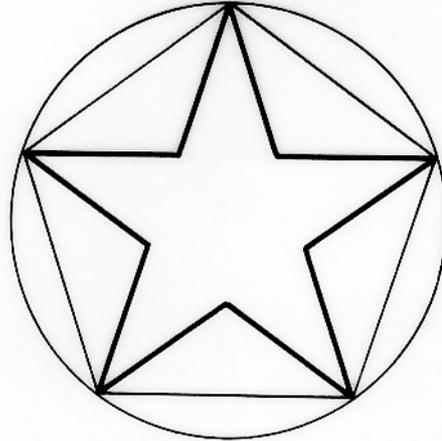
Question 4: Shady business
(5 marks)

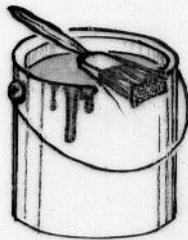Here is a grid with some shaded squares.

The corresponding grid below is derived from the first one: the numbers indicate for each square in the first grid the number of shaded squares touching it. Touching means at a side or a vertex.

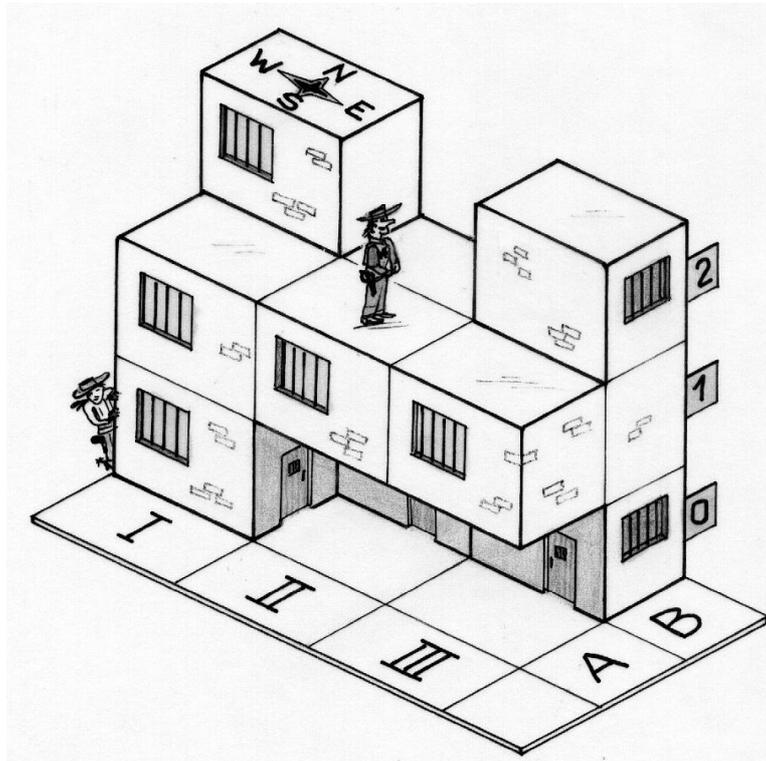Now here is a grid with just numbers.

Find the grid with shaded squares which corresponds to this number grid.

Question 5: Outlaw breakout
(7 marks)

The Dalton Brothers are four ruthless outlaws from the Wild West. Three of the four, Bill, Grat and Emmett, have been imprisoned. Each one is locked up on his own in one of the 12 cells of the prison shown here. Each cell has only one window.

In order to set his brothers free the fourth brother, Bob, uses this information:

- *The window of Bill's cell faces south.*

- *Bill is on the floor above Grat.*

- *The window of Grat's cell faces east.*

- *Emmett is on the 2nd floor in a cell which lies more to the west than Grat's cell.*

- *There is just one cell beneath Bill's.*

On the diagram, you can see the prison warden at position (2, A, II).

Help Bob set his brothers free by finding the position of each brother. Justify your answer

Question 6: Where's ~~Wally~~ Bryan?
(5 marks)

The seating plan for Bryan's class is shown on a square grid. Each small cross represents the position of a pupil. Two people cannot see each other if there is someone on the straight line that joins them. For example, Emmy cannot see Sophie because Thomas is on the line joining Emmy and Sophie. Mr Pascal, their teacher, cannot see Bryan.

From her place at the back of the class, Emmy can see Bryan and can also see her teacher.

Madame Germain, the headteacher who has just come in to speak to the class, cannot see Bryan.

Bryan can see two thirds of the pupils in the class.
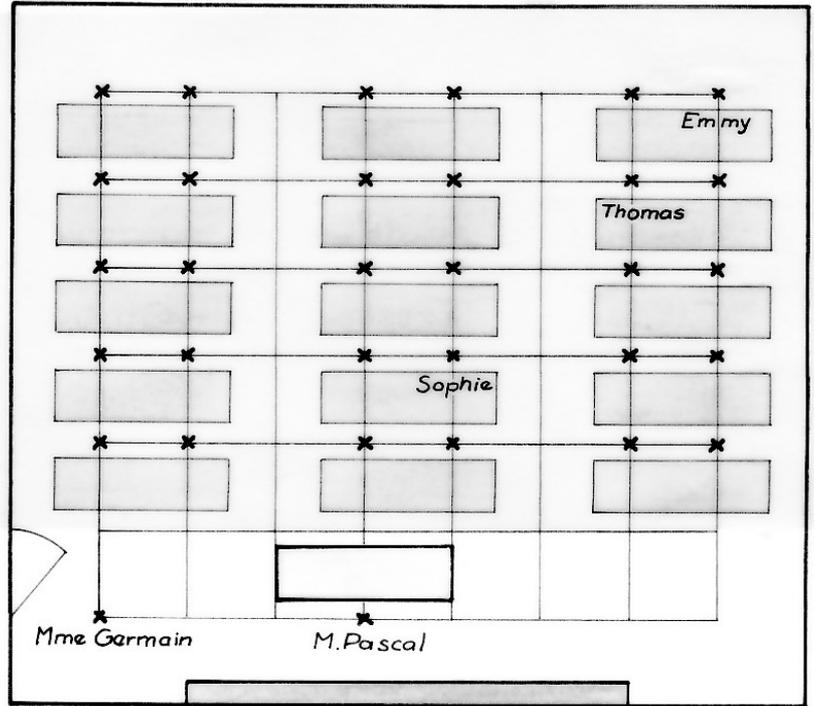
Make a sketch of the seating plan for the class and show where Bryan is sitting.

Question 7: Cut down to size
(7 marks)

To show off his collection of cubes of side 4 cm, Eliot makes a display support in the shape of a regular tetrahedron, cut down so that the cube can be held in the space. Three vertices of the cube rest on three edges of the tetrahedron.
Here are two views:

$$QV = VT = TU = \frac{QU}{2}$$
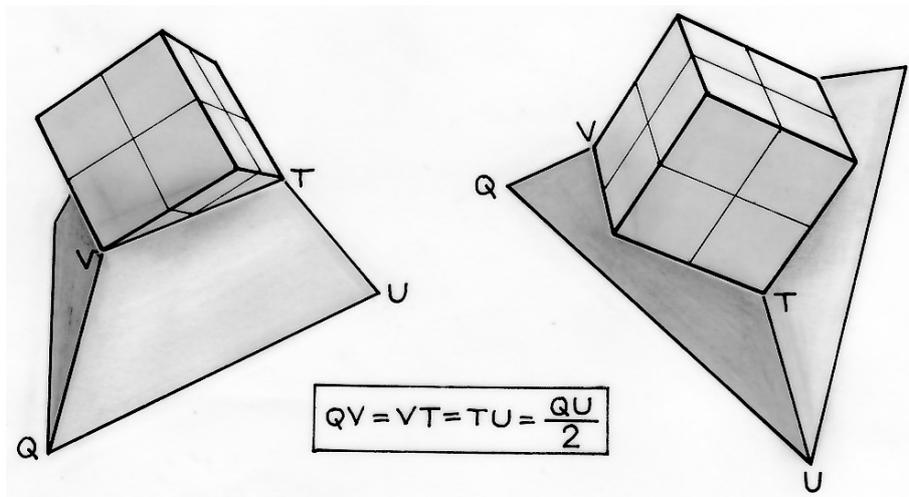
Draw a net of the four faces of the display support.

Question 8: Meeting your match
(5 marks)

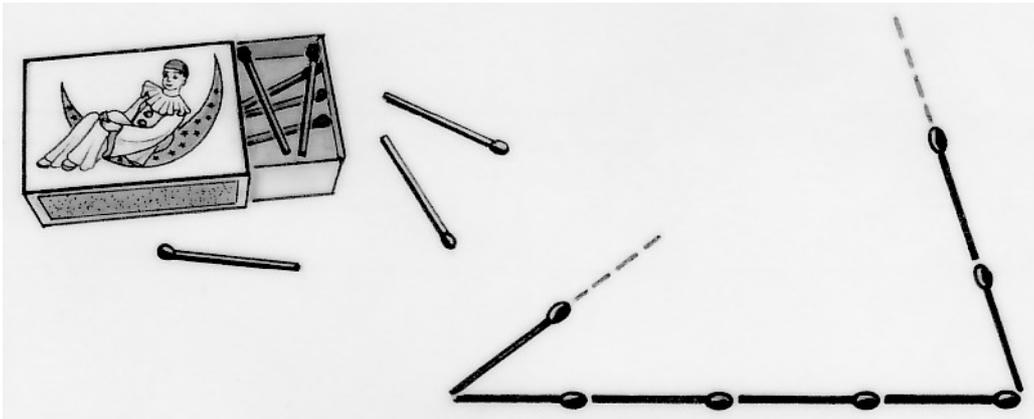With 24 matchsticks, all of the same length, you can construct a triangle with each side made up of matchsticks lined up head to tail.

How many different triangles can be made using all 24 matchsticks?
Write down all the possible solutions.

Question 9: A fishy tale
(7 marks)

Two fish swim in a circle in the same direction in their cylindrical aquarium. Both fish swim at a constant speed.
- at 18h 04m 00s both fish are in the same place, one underneath the other
- at 18h 04m 36s the blue fish is just starting its second lap while the red fish is already on its second lap
- at 18h 05m 30s the two fish are diametrically opposite each other.

How long does the red fish take to do one lap of the aquarium? Justify your answer.

18ᴴ 04' 00"   18ᴴ 04' 36"   18ᴴ 05' 30"
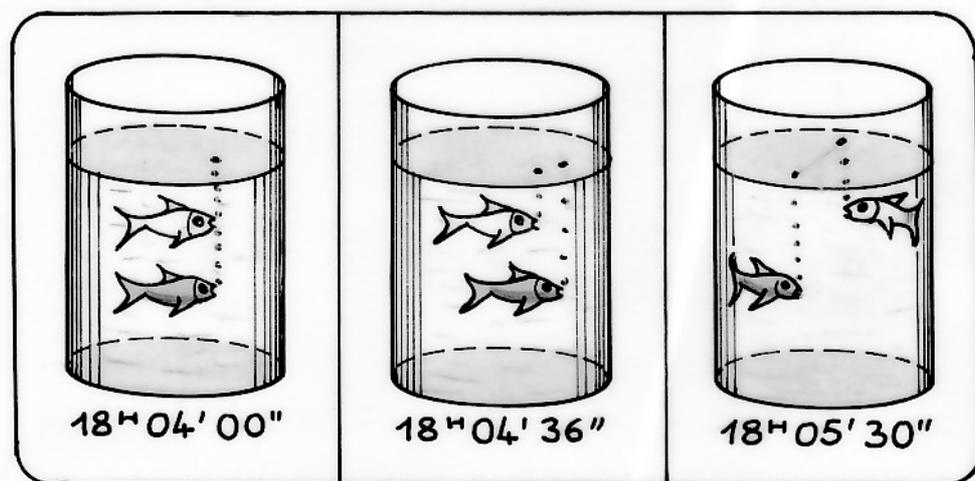
Question 10: And where is the way out?
(10 marks)

Here is the flow chart for a computer programme. Test out the programme for n = 11 and for another two values.

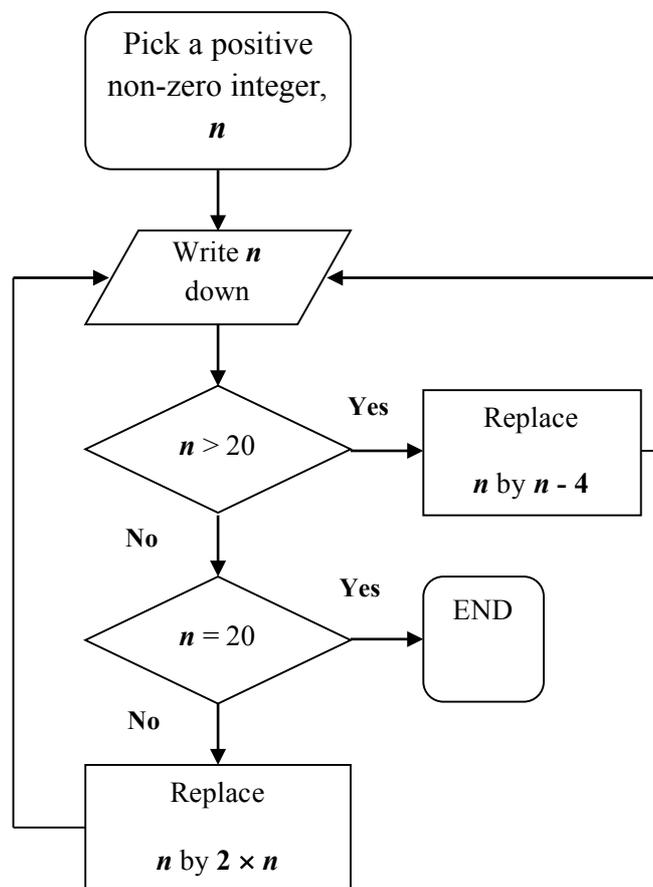*Will the programme always stop no matter what non-zero positive integer is chosen at the start? Explain your answer.*
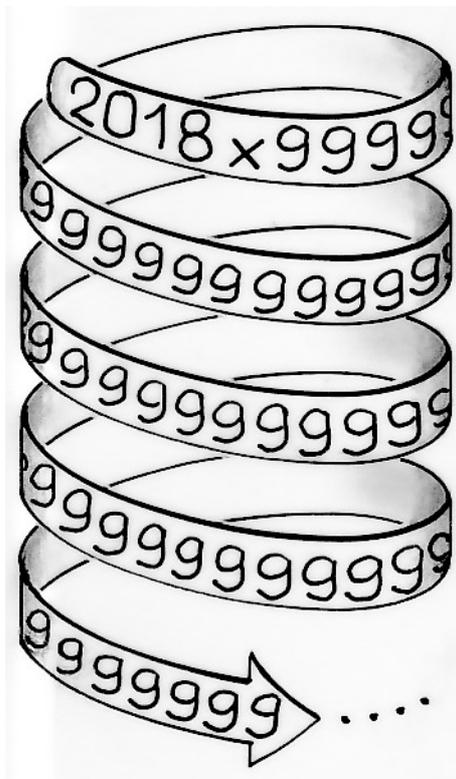
```
          ┌─────────────────────┐
          │   Pick a positive   │
          │  non-zero integer,  │
          │          n          │
          └─────────────────────┘
                     │
                     ▼
          ╱─────────────────────╲
          │      Write n         │◄─────────────┐
          │       down           │              │
          ╲─────────────────────╱              │
                     │                          │
                     ▼                          │
              ╱─────────╲      Yes    ┌──────────────┐
              │  n > 20  │───────────►│   Replace    │
              ╲─────────╱             │  n by n - 4  │
                   │                  └──────────────┘
                  No
                   │
                   ▼
              ╱─────────╲      Yes    ┌──────────┐
              │  n = 20  │───────────►│   END    │
              ╲─────────╱             └──────────┘
                   │
                  No
                   │
                   ▼
          ┌─────────────────────┐
          │      Replace        │
          │    n by 2 × n       │
          └─────────────────────┘
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Question 11:   Dial 999 ...
Senior classes only (5 marks)

$2018 \times 999.......999$

where the second number consists of 2018 digits, all of them 9.

What is the sum of the digits in the answer to this multiplication? Justify your answer.

Question 12: Percent-age-ism
Senior Classes only (7 marks)

In a town of 5,000 inhabitants, there are only young people and old people.
However, 20% of the young ones consider themselves to be old; and 10% of the old people consider themselves as young. The others just accept themselves for what they are.
Everyone in this strange town is asked the same question: "Are you old?".
34% of the inhabitants answer yes!

How many young people live in the town? Justify your answer.
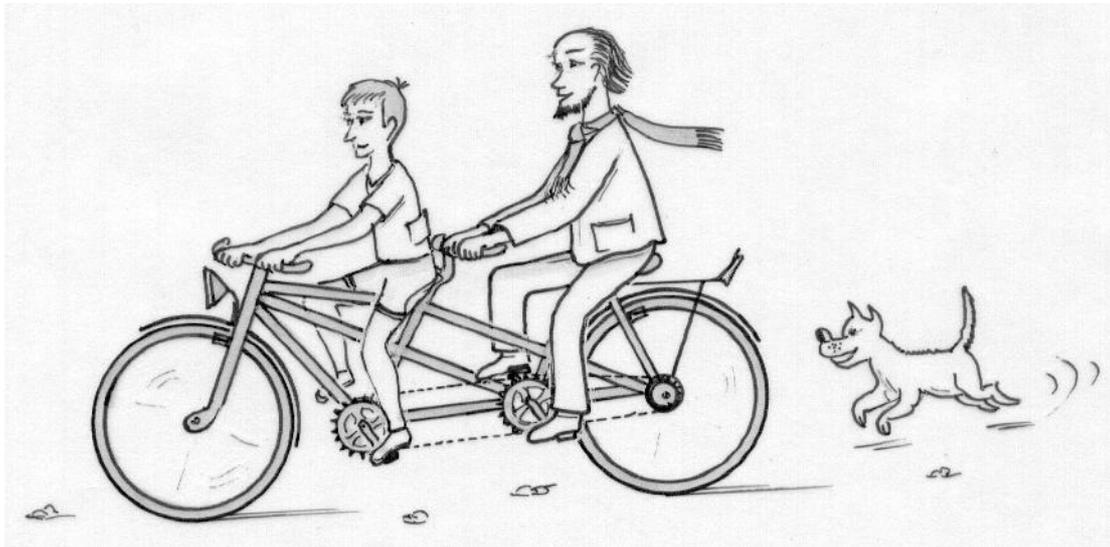
# Question 13: Tree-angular fence
Senior classes only (10 marks)

Three trees are planted at the vertices of a right-angled isosceles triangle. A fourth tree is planted at the mid-point of the hypotenuse as shown in the diagram.
To allow each tree to grow properly the gardener has made sure there is a circular area of radius 6m around each one.
He now wants to protect them by a fence.
The trees are shown here as points and the fence as the dotted lines.

Calculate the length of the fence to the nearest metre.
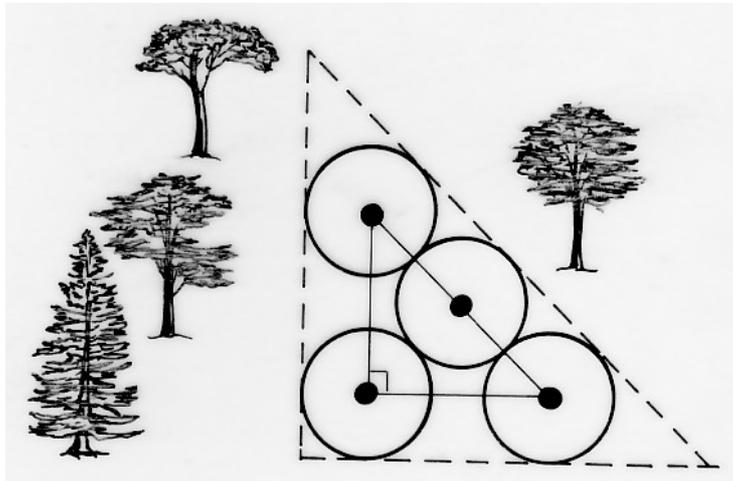
Question 13 (Pro) : Disc-qualified?
Senior classes only   (10 marks)

Is it possible to cut out two circular discs of radius 3.5cm from a rectangular piece of card that measures 13 cm by 10.5 cm?

Explain your answer.