



Mathématiques **SANS** **F**rontières **2018**

Spring 2018

Even partial solutions and attempts can gain marks.

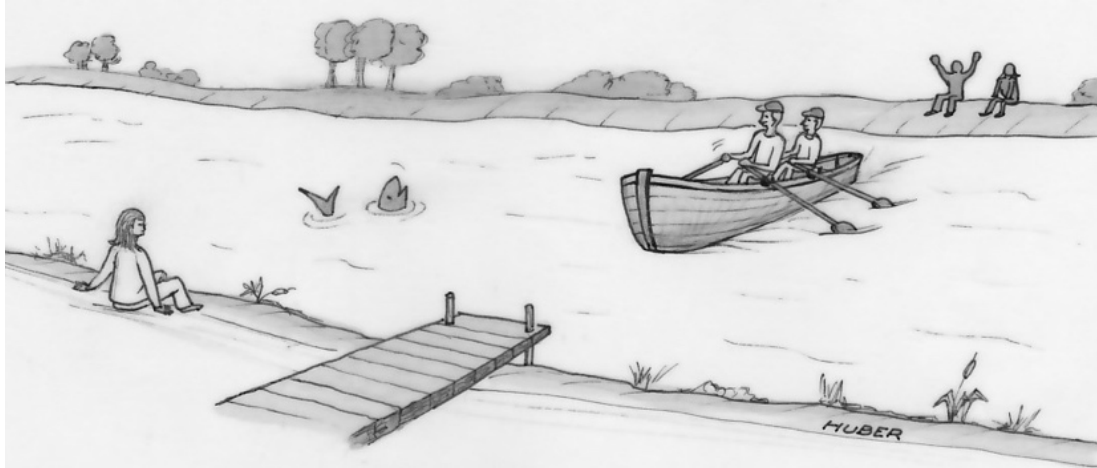
Neat and careful work is important.

Hand in only one team answer sheet for each question.

QUESTION 1 *Rame sec*

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

7 marks



Aline, H el ene, Zo e, Pierre et Jules veulent traverser une rivi ere au plus vite. Ils disposent d'une barque ne pouvant contenir que trois personnes au maximum.

Aline et Pierre sont des rameurs exp eriment es. Seuls ou   deux, ils peuvent traverser en deux minutes. Malheureusement, les trois autres amis sont tellement maladroits que d es que l'un d'entre eux se trouve   bord, la travers ee dure huit minutes..

Combien de temps faudra-t-il au minimum pour que les cinq amis se retrouvent de l'autre c ot e de la rivi ere ? Expliquer.

Alina, Helene, Zo e, Peter und Julian wollen so schnell wie m oglich einen Fluss  berqueren. In ihrem Ruderboot ist aber nur f ur h ochstens drei Personen Platz.

Alina und Pierre rudern sehr gut. Alleine oder zu zweit k onnen sie den Fluss in zwei Minuten  berqueren. Leider sind die anderen so ungeschickt, dass die  berfahrt acht Minuten dauert, sobald einer von ihnen an Bord ist.

Wie lange dauert es mindestes, bis alle f unf Freunde am anderen Ufer sind?

Erkl art eure Antwort.

Aline, Elena, Zoe, Pietro e Giulio desiderano attraversare un fiume il più velocemente possibile.

Hanno a disposizione una barca che contiene al massimo tre persone.

Aline e Pietro sono dei rematori esperti. Da soli o in due, possono attraversare il fiume in due minuti. Sfortunatamente, gli altri tre amici sono così maldestri che, se uno di loro è a bordo, la traversata dura otto minuti.

Quanto tempo sarà necessario come minimo affinché i cinque amici possano ritrovarsi sull'altra sponda? Spiegate la vostra risposta.

Aline, Elena, Zoe, Pedro y Julio quieren cruzar un río lo más rápido posible. Disponen de una barca que solo puede transportar tres personas como máximo.

Aline y Pedro son remeros experimentados. Solos o con dos, pueden cruzar en dos minutos. Desgraciadamente, los otros tres amigos son tan torpes que desde que uno de ellos se encuentra a bordo, la travesía dura ocho minutos.

¿Cuánto tiempo, como mínimo, hará falta para que los cinco amigos se encuentren al otro lado del río? Explica tu respuesta.

QUESTION 2 *Building blocks*

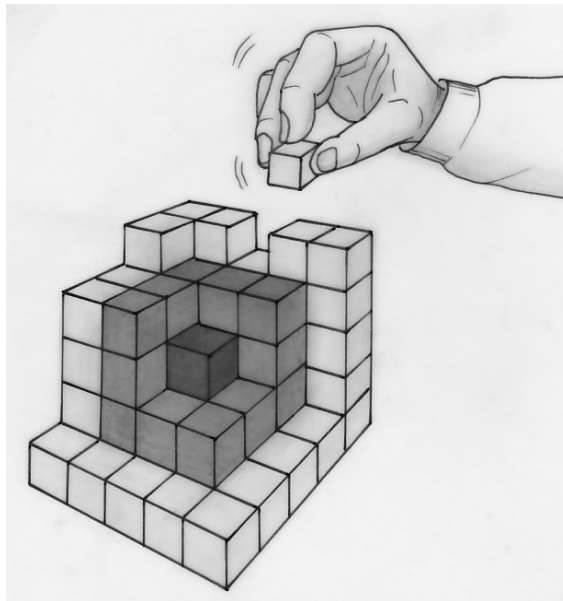
Ravane, Bernard and Jeanne are playing with small cubes of identical size.

Ravane has a small red cube weighing 5 grams.

Bernard surrounds Ravane's cube with small blue cubes, each weighing 8 grams, so that the new structure is also a cube.

Jeanne places small green cubes, each weighing 12 grams, around Bernard's cubes to form a new cube made up of 125 small cubes.

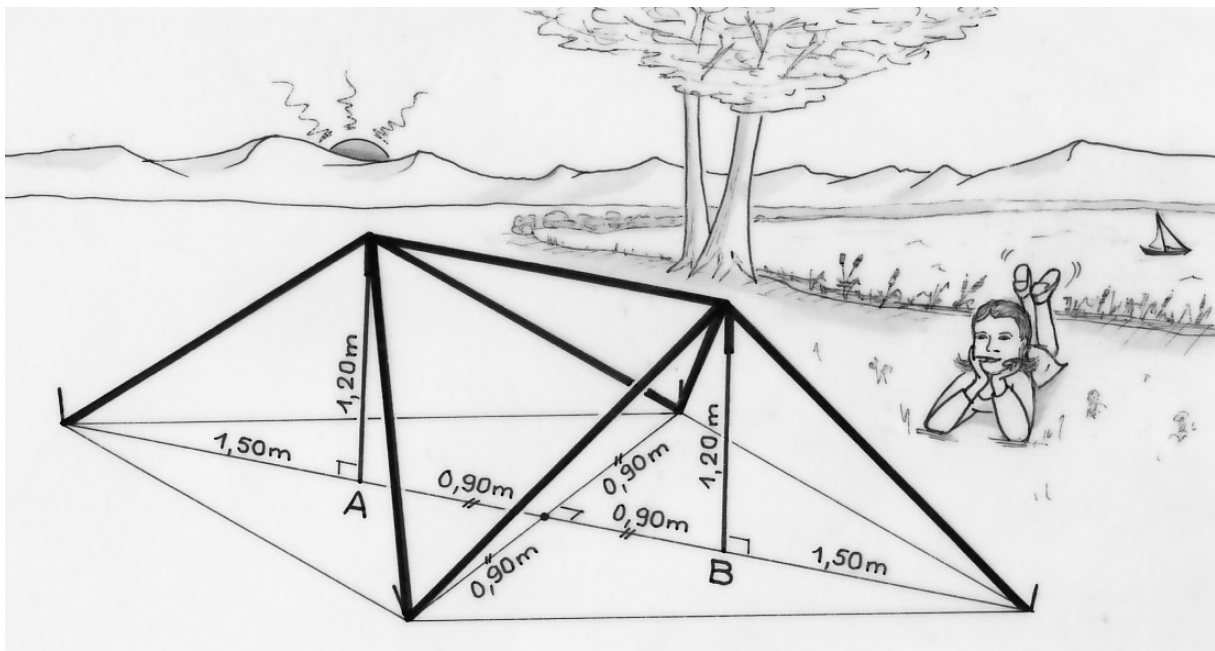
Calculate the total mass of the final cube.



5 marks

QUESTION 3 *Tak Tent*

7 marks



Tula is designing a makeshift tent from a piece of cloth. To do this, she uses her walking sticks each of height 1.2 metres as the tent poles placed vertically at points A and B, which are 1.8 metres apart.

She uses cords, held to the ground by pegs, to keep the tent in place. One cord is placed over both sticks and pegged on either side of the line joining A and B. One peg is 1.5 metres away from A, the other 1.5 metres from B.

Two other pegs are placed along the perpendicular bisector of the line AB, each one 0.9 metres on either side of the midpoint of AB. A cord connects these two pegs to the two tops of the sticks.

Each face of Tula's tent is a triangle.

To complete her design, she needs to cut out the pattern from the cloth.

Draw a net of Tula's pattern, using a scale of $1/30$.

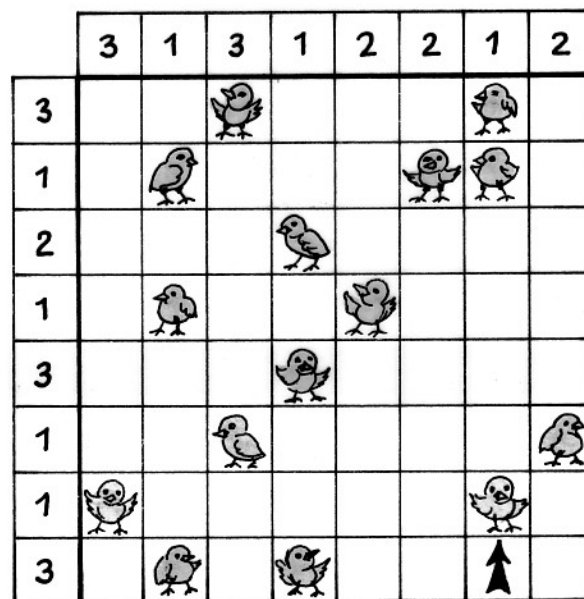
QUESTION 4 *Nursery*

5 marks

To grow chicks, a farmer places them in little boxes in a chicken coop. He installs heating lamps in boxes in the coop according to the following rules:

- the box with a lamp has only one side in common with that of the chick's box;
- the heating lamp must be pointed towards the chick's box;
- to avoid overheating, two heating lamps cannot be placed next to each other (including diagonally).

The diagram below shows a plan of the chicken coop. The numbers indicate the number of heating lamps in each row and column. The arrow represents a lamp and the direction in which it is pointing.



Copy and complete the diagram to show the placement of the heating lamps in the chicken coop.

QUESTION 5 *Some Sums*

What is the smallest number whose digits add up to 12? Or to 38? Or 2018?

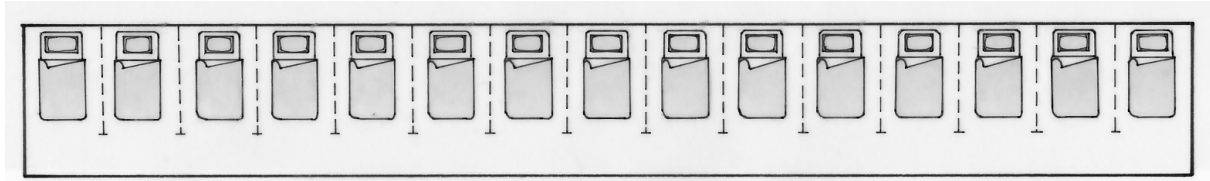
Explain your answer.



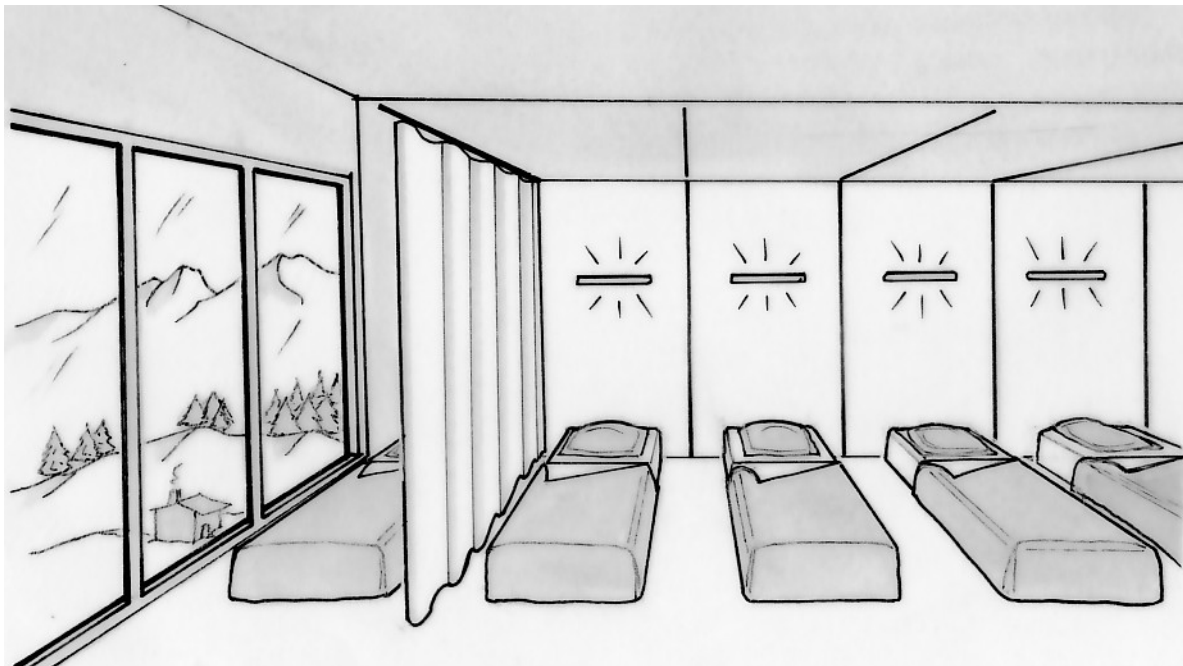
7 marks

QUESTION 6 *Curtains!*

A youth hostel in the Scottish Highlands has a large dormitory with 15 beds arranged side by side, as shown in the picture below.



The hostel manager regularly hosts hikers who arrive in groups of varying sizes. He wants to place four curtains, which can be opened or closed, to create all the possible spaces from one to ten beds as needed for the different sizes of group.



Where should he place the four curtains?

5 marks

QUESTION 7 *They'll never know*

7 marks

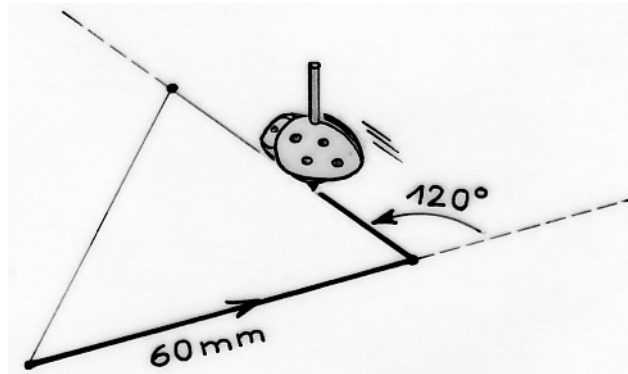
Pierre has been given a Computer-aided design device which can be programmed to draw lines as it moves over a sheet of paper.

The device is given its instructions as:

Go forward mm

Turn °(the device does not move forward but turns on the spot towards the left)

Repeat times



Some examples include:

- to draw an equilateral triangle of sides 6cm, you would programme:
Repeat 3 times (Go forward 60mm and then turn through 120°)
- to draw a square of side 6 cm, you would programme:
Repeat 4 times (Go forward 60mm and then turn through 90°).

Pierre wants to draw a circle of radius 10 cm. He thinks that if he draws a regular hectogon, a polygon of 100 sides, then no-one could tell the difference between that and a circle.

Write a programme that Pierre could use to draw the hectogon.

QUESTION 8 *The heart of the matter*

5 marks

Four joggers train using their smart watch to constantly measure and display their heart rate.

After consulting their watch, they are able to determine the type of exercise they are doing.

Here is some information to help them:

- the reserve heart rate (RHR) which is the difference between the maximum heart rate and the rest heart rate;
- each person has his own RHR; and
- the heart rate increases during an exercise session.

E = difference between measured heart rate and rest heart rate.	Type of exercise
$E < 0.6 \times \text{RHR}$	Warm up or warm down
$0.6 \times \text{RHR} \leq E < 0.7 \times \text{RHR}$	Basic endurance
$0.7 \times \text{RHR} \leq E < 0.8 \times \text{RHR}$	Active endurance
$E \geq 0.8 \times \text{RHR}$	Anaerobic activity

Name	Rest heart rate	Maximum heart rate	RHR	Measured heart rate
Marc	60	180	120	108
Luc	65	175		155
Mathieu	70	170		135
Jean	80	162		142

Marc's exercise is of the " warm up or wind down " type. Find the type of exercise that Luc, Matthieu and Jean have done. Justify your answers



QUESTION 9 *Price at the pump*

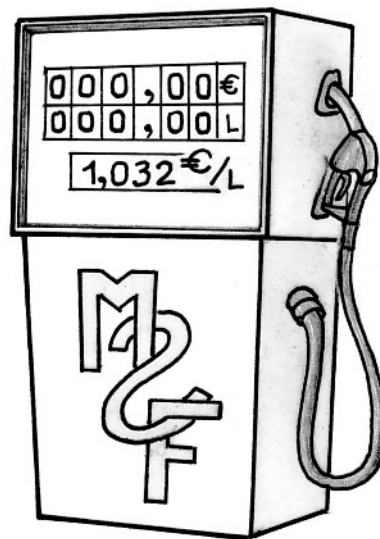
7 marks

A fuel pump display is shown below :

0	0	0	,	0	0	€
0	0	0	,	0	0	L
1,032 € / L						

Draw an example of this display for which the two numbers - volume (in litres) and price (in euros) - differ by exactly 1.

Can this be seen again for other displays?



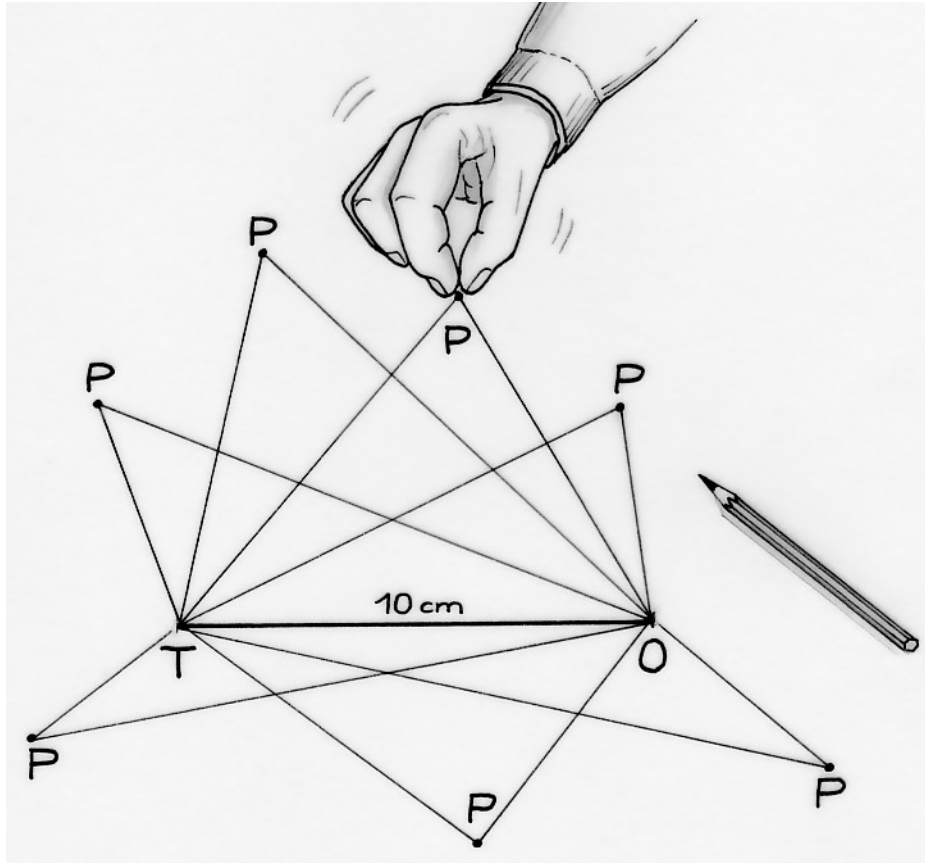
QUESTION 10 *Whatever*

The line OT is 10 cm long.

You have to draw a triangle OPT which looks neither isosceles nor right-angled.

To do that you want to make sure that the vertex P is more than 1 cm away from any of the vertices C where OCT is an isosceles or a right-angled triangle.

Draw the line OT and colour in the area where the point P could be placed.



10 marks

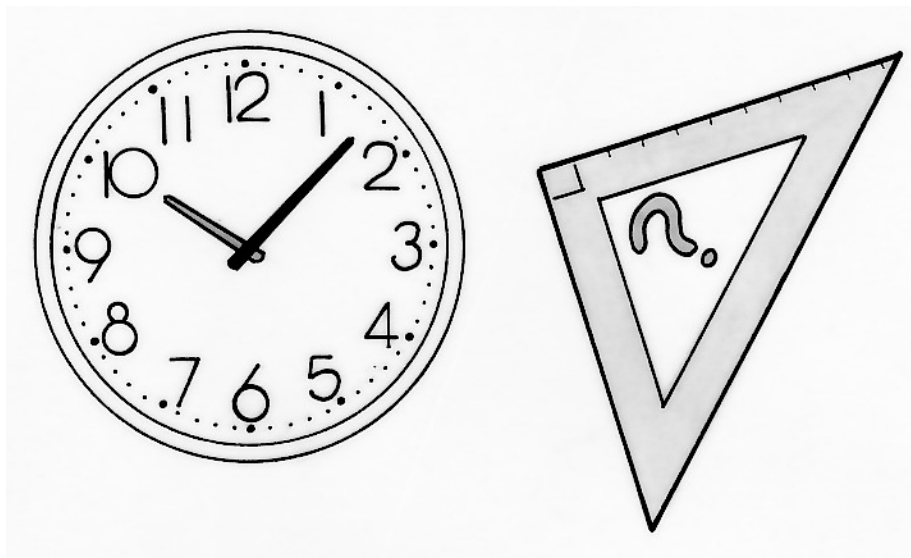
QUESTION 11 *Right time*

5 marks

A clock has a long hand to show minutes and short hand to show hours.

Between midday and midnight, how many times do the two hands make a right angle?

Explain your answer.

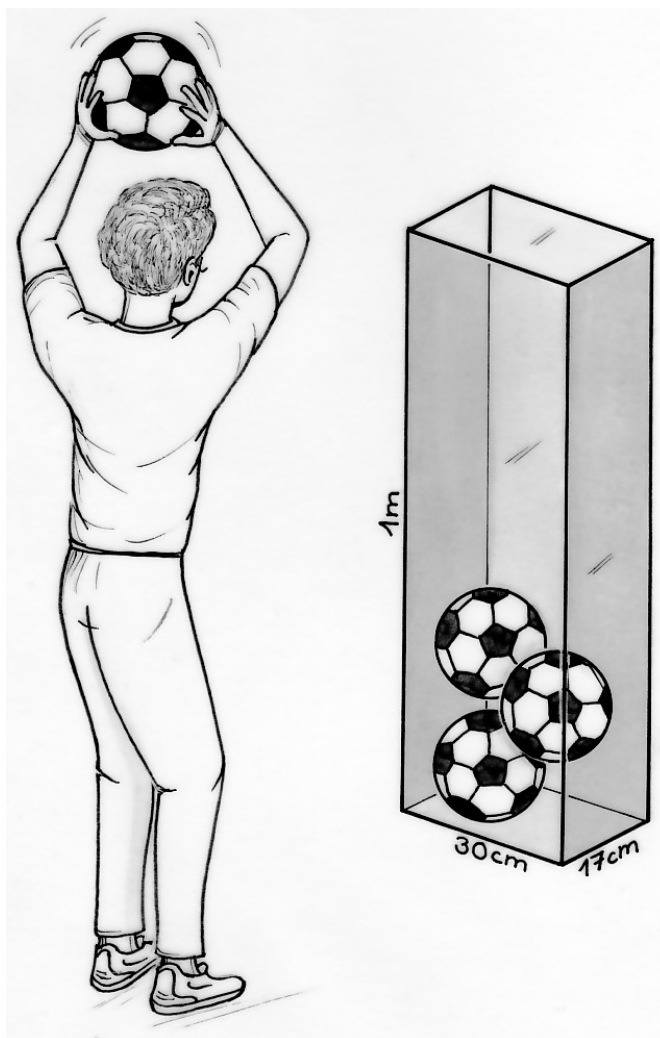


QUESTION 12 *Box clever*

A football coach wants to put footballs of diameter 17cm in a box. The box is a cuboid with base 17cm by 30cm and height 1m.

Find the maximum number of balls that can be put into the box so that the coach can still put on the lid and close the box. Justify your answer.

7 marks



QUESTION 13 *Astronomical figure*

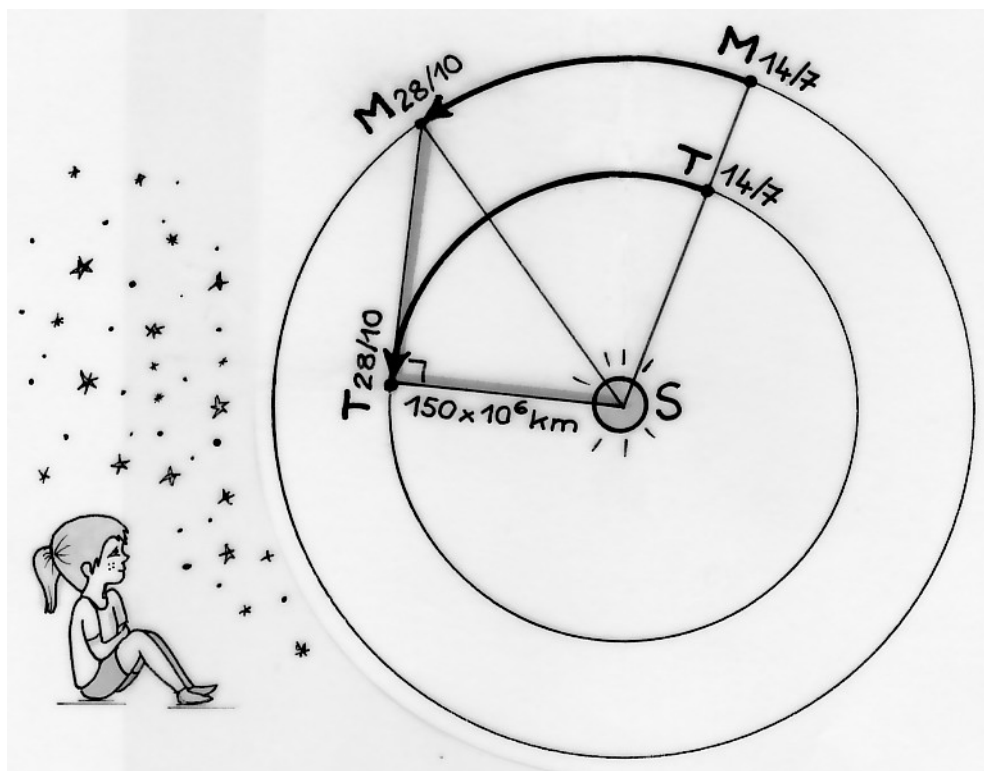
10 marks

One 14th July Mars, Earth and the Sun were in a straight line. Earth was between Mars and the Sun. 106 days later on the 28th October it was found by observation from Earth that the angle Sun-Earth-Mars was a right angle.

We can simplify by assuming:

- that the Earth goes once round the Sun, in a circle, at constant speed, in 365 days;
- that Mars goes once round the Sun, in a circle, at constant speed, in 687 days;
- the paths taken by Earth and Mars are in the same plane;
- the distance from the Earth to the Sun is about 150 million kilometres.

Work out a good estimate of the distance of Mars from the Sun.



Note: the diagram shows the Sun, *S*, and Mars, *M*. The Earth (*la Terre*) is shown as *T*.