Lab School Paris

Mock Brevet Exam

Mathematics

April 2023

Duration of the test: two hours

calculators: allowed

► The wording has four pages (1/4 2/4 3/4: text; 4/4: figures), in addition to this cover page.

► The wording is made up of eight independent exercises, labeled 1, 10, 15, 25, 29, 36, 37 & 52. You can process them in any order that suits you.

► The test is graded out of one hundred points.

► ►► Each answer must ***be preceeded by a justification***.

► ►► The ***English quality*** and the ***clarity of reasonning*** will be decisive for the evaluation.

► Any trace of research will be taken into account in the evaluation.

15 GLOBAL WARMING 17pts 15 min

Human activities produce carbon dioxide (CO_2), which contributes to global warming. The following graph shows the evolution of average atmospheric CO_2 concentration (expressed in ppm) as a function of time (expressed in years).

[top caption] Atmospheric CO_2 concentration (in ppm)
[right caption] 450 ppm = average level not to be exceeded by 2100
[bottom right caption] (Source: WMO World Data Center)
[bottom left] 1 ppm CO_2 = 1 part per million CO_2 = 1 milligram of CO_2 per kilogram of air

1° *Determine graphically the CO_2 concentration in ppm in 1995, then in 2005.* **2pts**

2° One wants to model the evolution of CO_2 concentration as a function of time using a map g, where $g(x)$ is the CO_2 concentration in ppm as a function of year x.

a. *Explain why an affine map seems appropriate to model CO_2 concentration as a function of time between 1995 and 2005.* **3pts**

b. Arnold and Billy each propose an expression for map g:
– Arnold proposes the expression $g(x) = 2x - 3\,630$;
– Billy proposes the expression $g(x) = 2x - 2\,000$.
Which expression best models the evolution of CO_2 concentration? **4pts**

c. *Using the function you chose in the previous question, indicate the year in which the value of 450 ppm is reached.* **4pts**

3° In France, thanks to photosynthesis, forests capture around 70 megatons of CO_2 per year, which amounts to 15% of 2016 national carbon emissions. *Calculate an approximate value, to the nearest megaton, of the mass of CO_2 emitted in France in 2016.* **4pts**

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29 COMPUTING PROGRAMS 8pts 15 min

Here are two computing programs:

PROGRAM A
Starting number
→ Add 10
→ Square
Result

PROGRAM B
Starting number
→ Add 20
→ Multiply by the starting number
→ Add 100
Result

1° *Show that, if 5 is chosen as a starting number, then both programs yield the same result.* **2pts**

2° *With Program A, which starting number must be chosen to get a nil result? Does this number yield a nil result for Program B too?* **3pts**

3° The teacher says both programs always yield the same result, whatever the starting number. *Are they right?* **3pts**

Reminder. Two triangles are qualified **similar** if their angles have same measures. When this is the case, the lengths of one triangle can be obtained by multiplying those of the other triangle by the same number, called **the reduction** or **enlargement coefficient**.

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10 COMPUTING PROGRAMS 12pts 15min

The following two computing programs are given:

PROGRAM A

Choose a number.
Subtract 5 from this number.
Multiply the result by the starting number

PROGRAM B

Choose a number.
Square this number.
Subtract 4 from the result.

1° Alice chooses number 4 and applies program A. *Show that she will obtain –4.* **1pt**

2° Lucie chooses number –3 and applies program B. *What result will she obtain?* **2pts**

Tom wants to find a number for which both programs will give the same result. He chooses x as the starting number for both programs.

3° *Show that the result of program A can be written as* $x^2 - 5x$. **4pts**

4° *Express the result obtained with program B as a function of x.* **2pts**

5° *What number is Tom looking for?* **3pts**

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25 FILLING & PAINTING A ROUND TANK 9pts 15 min

A tank is made up of two identical half-spheres linked by a 3 m long cylindrical part, all three of them being 1.8 m in diameter.

1° *What is the total capacity of this tank?* **4pts**

The outer surface of the tank is to be painted twice. The paint used is sold in 3 L buckets, each of which costs €60. The instructions state that one liter covers about 5 m².

2° *How much paint do I need to paint this tank?* **5pts**

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36 HOIST THE SAIL! 12pts 15min

For her own comfort, Lisa wants to install a triangular shade sail in her garden.
The area of the sail must be at least 8 m².

For each of the following three models, indicate whether it is suitable.

1° **2pts** 2° **4pts** 3° **6pts**

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52 EARTHWORKS 16pts 20min

Mrs Smith wishes to create a concrete terrace opposite her bay window. She makes the following drawing.

[caption in left parallelogram] Bay window
[caption in right rectangle] Terrace

To facilitate rainwater run-off, the terrace floor must be sloped.

The terrace is shaped like a right prism whose base is quadrilateral ABCD and height is segment [CG].

P is the point on segment [AD] such that BCDP is a rectangle.

1° Angle ∡ABP must measure between 1° and 1.5°. *Does Mrs Smith's project satisfy this condition?* **6pts**

2° Mrs Smith would like to have the concrete required for her terrace delivered to her home. She calls in a specialist company. *Using the information below, determine the amount of the invoice issued by the company*. **10pts**

INFORMATION 1 Distance between the company and Mrs. Smith's house: 23 km.

INFORMATION 2 Volume of a right prism = Area of prism base × Height of prism.

INFORMATION 3 – SPECIALIZED COMPANY'S PRICING CONDITIONS Delivery charge: €5 per km covered by the truck. Maximum capacity of truck-mixer: 6 m^3. Price per m^3 of concrete: €95. The company charges for round-trip distances (company ↔ delivery site) covered by the truck-mixer.

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37 SIMILAR TRIANGLES 16pts 15min

Consider triangle ABC above, right-angled at A, with ∡ABC = 30° and AB = 7 cm. Point H is the foot of the height from A.

1° *Draw the full-scale figure. Leave the construction lines visible.* **3pts**

2° *Prove that AH = 3.5 cm.* **5pts**

3° *Show that triangles ABC and HAC are similar.* **4pts**

4° *Determine the reduction coefficient from triangle ABC to triangle HAC.* **4pts**

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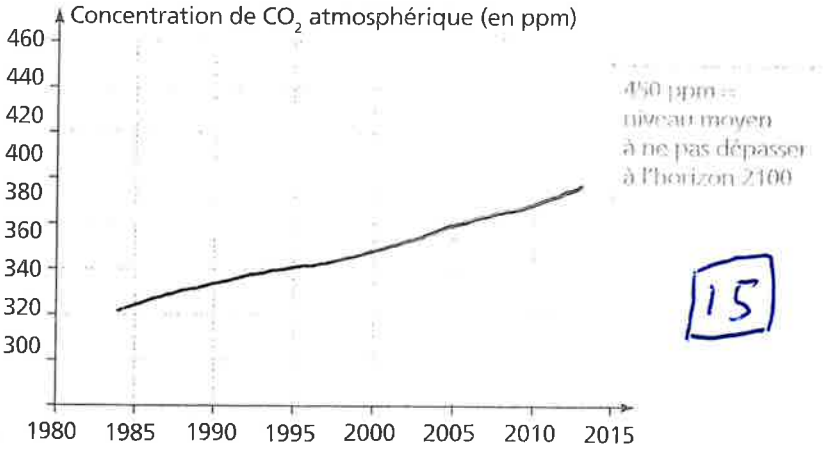
1 SHARING A TREASURE 10pts 10min

The captain of a ship has a treasure consisting of 69 diamonds, 1 150 pearls and 4 140 gold coins.

1° *Decompose 69, 1 150 and 4 140 into products of prime factors.* **5pts**

2° The captain divides the treasure equally among the sailors. *How many sailors are there knowing that all diamonds, pearls and coins have been distributed?* **5pts**

PICTURES & FIGURES



(Source : Centre mondial de données relatives aux gaz à effet de serre sous l'égide de l'OMM)

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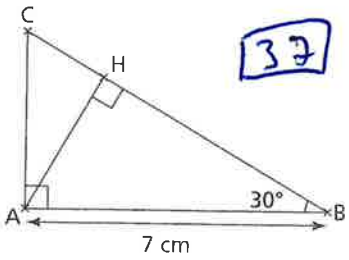

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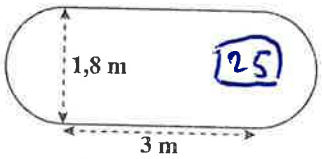

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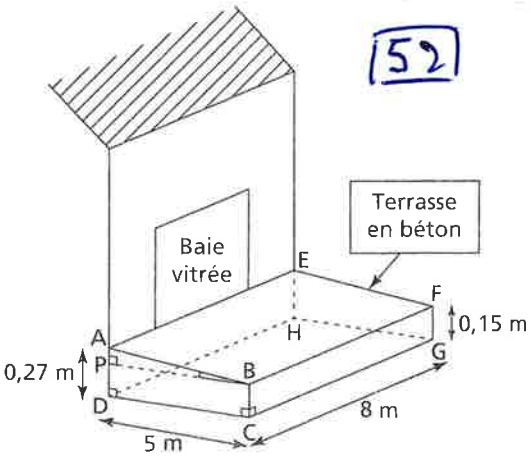

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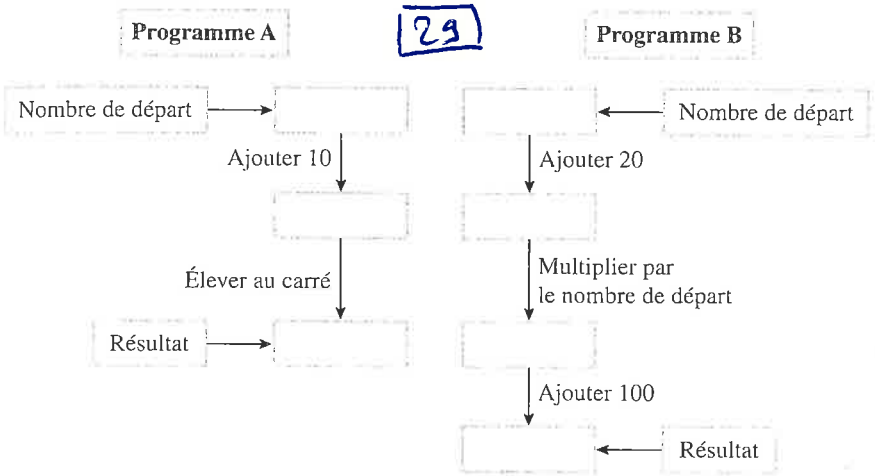

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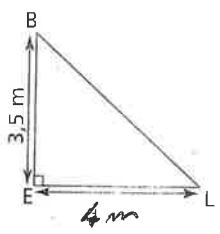

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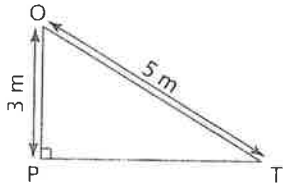

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