# Blind students and mathematics Good practices in France

## Intellectual Output 03

April 2022


PROGETTO DDMATH

Digital learning in mathematics

for blind students

ERASMUS+ Program

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DDMATH

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Project within the ERASMUS+ program – School Education Gateway – Action KA2 - Strategic partnerships for digital education KA226 – Convention n. 2020-1-IT02-KA226-SCH-09557

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| **Abstract:** a history, the paths, the initiatives launched and the good practices existing today and available for blind children, usable by the school for mathematics and more generally for scientific texts | |
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# Blind pupils and good practice in mathematics in France

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## 1 Introduction

Before the advent of large-scale computing, pupils with visual impairments had no access to these tools. Their only options were tablets with a punch or the (noisy) Perkins Braille machine to produce documents. As a result, it was necessary to de-transcribe the documents into Braille in order to be able to read the pupils' work.

At the beginning of the 90s, with the democratisation of IT tools for individuals, the first Braille computers with around twenty Braille cells appeared. For example, the company Eurobraille developed and marketed the CLIO-noteBRAILLE Braille display.

*Figure 1 : clio-notebraille*

IT tools have enabled people with disabilities to use a computer with a Braille display and to access information. In the school environment, exchanges with teachers have, in some cases, been able to take place more directly, without the delay associated with the de-transcription of Braille sheets produced by the tablet or Perkins. Thanks to the development of IT tools, pupils now have a wide choice of tools with which to follow lessons in an ordinary environment, such as the Braille notepad, the Braille pad associated with a laptop, the computer itself and screen readers. Although IT tools offer students a great deal of autonomy, they cannot obtain an overview of a document in the same way as a sighted person. What's more, using IT tools requires specialised learning and dedicated teaching.

Since the law of 11 February 2005 "for equal rights and opportunities, participation and citizenship of people with disabilities", pupils with disabilities have been included in mainstream classes as early as possible.

(https://handicap.gouv.fr/la-loi-du-11-fevrier-2005-pour-legalite-des-droits-et-des-chances)

If we base ourselves on the results of the recent study carried out in France as part of the Homère project [1], we can say that "The schooling of respondents aged between 3 and 29 whose visual impairment appeared before the age of 18 is completed or has been completed at least in part :

- In ordinary classes for 80% of them,
- In inclusive schooling with the support of a ULIS system for 14%,
- In Établissements Régional d'Enseignement Adapté pour Déficients Visuels (EREADV) for 12%,
- INJA (Institut National des Jeunes Aveugles) or IJA (Institut des Jeunes Aveugles) for 9%,
- 4% in an internal teaching unit (UE) in a medical-social establishment,
- 1% in an external teaching unit (UEE) in a medical-social establishment,
- 4% are or have been out of school for some time, and 1% are or have been home-schooled".

The study also indicates that schooling in an ordinary environment has progressed, since previous studies show that "59% of pupils with disabilities attended ordinary classes, 23% were included with the support of a ULIS (Localized Unit for School Inclusion) and 16% attended a specialised establishment".

This document sets out in detail the various options available for the education of young people in inclusive and specialised settings, with descriptions and examples of specialised structures, as well as possible training courses and duties for specialised teachers and transcribers.

After a brief description of the French mathematical Braille code, and before concluding, you will find the main tools used in learning mathematics, which will be described according to age and context of use.

## 2 The different teaching contexts in France

In France, the approach to teaching visually impaired pupils is characterised by the teacher taking into account and adapting to the situation of each pupil. This differentiated approach enables the pupil to be effectively included in the school system. There are a number of schooling options, ranging from teaching in a specialised institute such as the INJA in Paris, to inclusion in a traditional school structure with the support of specialised CAEGADV teachers.

These specialist establishments, such as the Institut National des Jeunes Aveugles (INJA) or the Institut des Jeunes Aveugles in Toulouse (IJA), have a long tradition of teaching and supporting visually impaired pupils, and have a wealth of expertise in the education of these pupils. These establishments offer a full range of education for pupils, from nursery to final year, in situ or inclusive.

Inclusive schooling is implemented in conjunction with the Personalised Schooling Project (PPS), which defines the specific needs of each pupil and the adaptations required to enable them to access the same learning as their peers. As a result, the pupil can follow an adapted schooling programme, which may include rest periods, exemption from certain lessons, rehabilitation periods, individual lessons within the host establishment or in a specialised institute.

Below are a few examples of specialised institutes that either take full responsibility for teaching blind pupils or support inclusion in a normal class.

The INJA Institut National des Jeunes Aveugles (http://www.inja.fr/Default/presentation-de-linja.aspx) is a National Public Institution for Specialised Teaching and Education for blind and partially-sighted young people, under the authority of the Ministry of Social Affairs and Health. It caters for blind and partially-sighted pupils from nursery school to the end of secondary school, on a boarding or day school basis. Students may : - either receive help in class and/or the services of specialist teachers in conjunction with the host teachers. This may take the form of modified timetables with individual lessons in the host establishment or in a specialised institute (http://www.inja.fr/Default/eleves-en-inclusion.aspx) - or continue their schooling entirely in a specialised environment in the establishment (http://www.inja.fr/Default/eleves-in-situ.aspx).

Similarly, in Toulouse, the IJA (Institut des Jeunes Aveugles), founded in 1866, is a special education centre for the visually impaired, catering for more than 500 visually impaired children, teenagers and adults, with or without associated disorders. A detailed presentation and description can be found at (https ://www.ijatoulouse.org/la-fondation/qui-sommes-nous/).

## 3 Specialized teachers and transcribers

Specialized teachers play an important role in adapting teaching to the specific needs of each visually impaired student. They advise the host teacher, proposing specific teaching methods and materials adapted to the needs of the visually impaired pupil.

**Specialized teachers** provide adapted teaching to complement the work of the host teacher, and are certified by the French Ministry of Health and Social Affairs (CAEGADV). https ://handicap.gouv.fr/ecole-inclusive-des-nouveautes-dans-lenseignement-specialise-des-jeunes-deficients-sensoriels

This course is proposed by the Université de Savoie, and the course booklet is available here https ://www.univ-smb.fr/cnfeds/wp-content/uploads/sites/25/2019/09/livret-peda-caegadv-cnfeds-2019.pdf

The role of **transcribers or document adapters** is to make documents accessible to people with visual impairments (visually impaired, blind) or DYS disorders (dysphasia, dyslexia, dyspraxia, etc.).

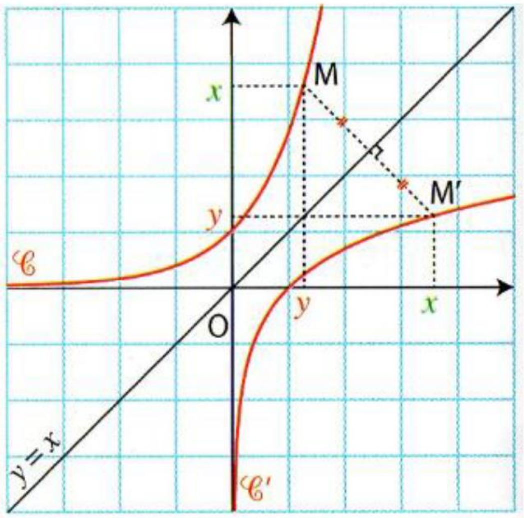
Sorbonne Université offers training courses for transcribers and adapters. https://www.fisaf.asso.fr/images/formaqualif/Plaquette_Licence_TA_2022-2024.pdf

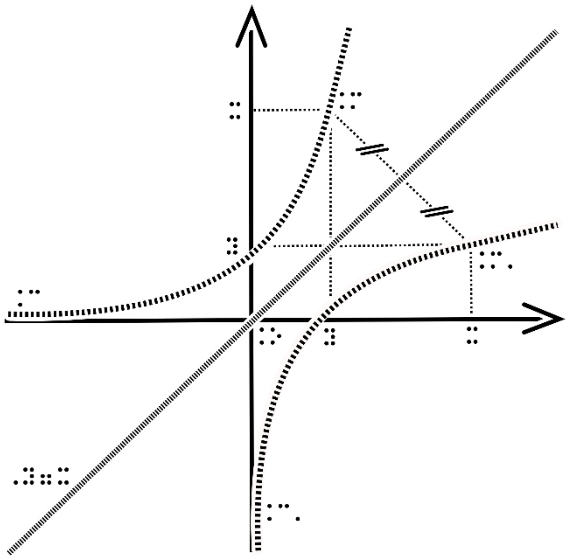
For mathematics, document transcribers make documents accessible to visually impaired students from documents written in "black", using specialized software such as NatBraille (available at http://natbraille.free.fr/) and Duxbury (available at https://www.duxburysystems.com/) to produce adapted Braille versions. They can also provide audio files to enable students to listen to the documents. They can also adapt visual documents by providing precise descriptions or creating Relief

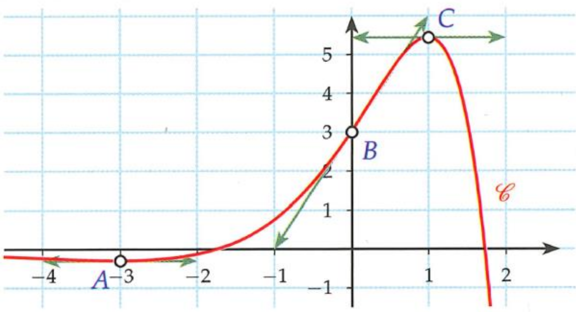
Drawings (DER) using special paper, such as Zytex2. They use software such as Inkscape or Adobe Illustrator to create these relief drawings.

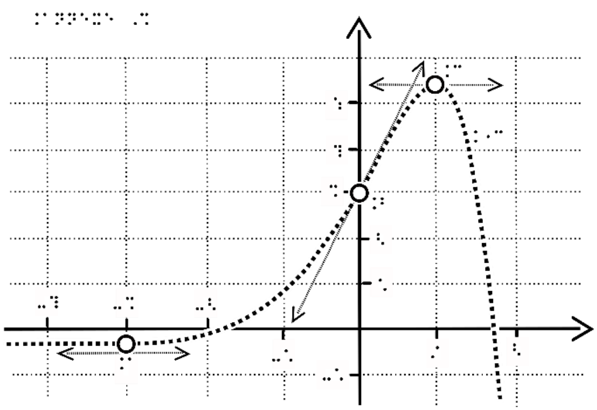
Below are a few examples of adapted documents, taken from the Sésamath Terminale S Mathematics book (ISBN: 978-2-210-10559-1).

Visually impaired students can benefit from these adaptations to access the content and information contained in the documents.





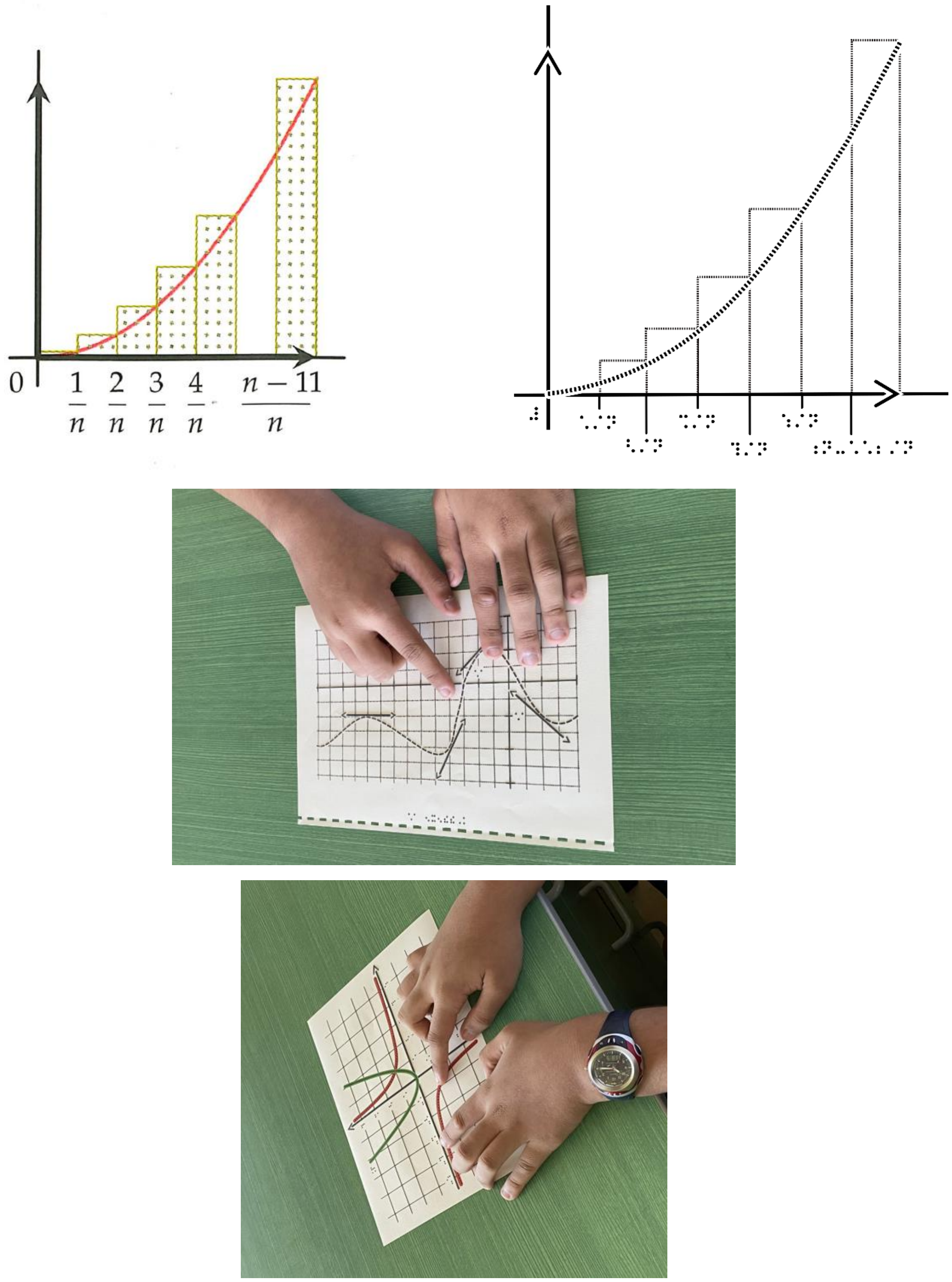



*Figure 2 : adaptations examples*

# 4 Mathematical Braille in France

The French mathematical braille code is defined in official documents, the "notation mathématique braille" (first edition, January 2007) and can be found at : https://www.avh.asso.fr/sites/default/files/notation_mathematique_braille2_0.pdf.

Unlike the "literary" Braille code, which is common to all French-speaking countries and known as CBFU (Code Braille Français Uniformisé), the mathematical notation is country-specific. In France, the code is linked to the Antoine Louis notation (https://fr.wikipedia.org/wiki/Louis_Antoine).

| Notation / chiffre | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Traditionnel | ⠼ | ⠁ | ⠃ | ⠉ | ⠙ | ⠑ | ⠋ | ⠛ | ⠓ | ⠊ | ⠚ |
| Antoine | ⠠ | ⠡ | ⠣ | ⠩ | ⠹ | ⠱ | ⠫ | ⠻ | ⠳ | ⠪ | ⠼ |

This code transcribes mathematical and scientific elements into 6-dot Braille. The code uses specific symbols to represent mathematical elements, sometimes it is necessary to assemble several Braille symbols to represent more complex elements.

The visual nature of mathematics, with its graphs, complex equations and diagrams, can make learning difficult for visually impaired students. In addition, they may encounter additional obstacles in the event of severe fatigue or other rehabilitations that require adjustments to the timetable.

As a result of their visual impairment, disabled students will find it difficult to visualize geometry sessions. This difficulty will be all the greater if the disability appeared early, or if his visual potential does not allow him to have a detailed vision of the elements.

French mathematical braille, like the braille used in chemistry, is based on 6-dot literary braille and uses specific symbols and notations to represent mathematical and scientific elements. Commonly used symbols have been designed to use as few dots as possible (multiplication ⠔, addition ⠖, subtraction ⠤, division ⠒, exponent ⠈ etc.) while less frequent symbols are an "assemblage" of several Braille symbols (intersection ⠘⠖, parallel to ⠘⠱, infinity ⠘⠉ etc.).

The French mathematical system is based on 6-dot Braille, to which we add the dot 6 at the beginning of the line to warn the reader that we have numbers/mathematical symbols to follow. When blocks (⠰⠆) are used, the code change indicator (dots 6 and 3 ⠄⠄) must be used at the beginning of the line. There is one exception: if a mathematical expression is not inserted in a text, then it is not necessary to use the mathematical braille indicator or the code change indicator. Instead, it's usually appropriate to put a dot 6 to warn the reader that a mathematical expression is about to follow.

## 4.1 Follow-up and learning of mathematical Braille in inclusive school settings

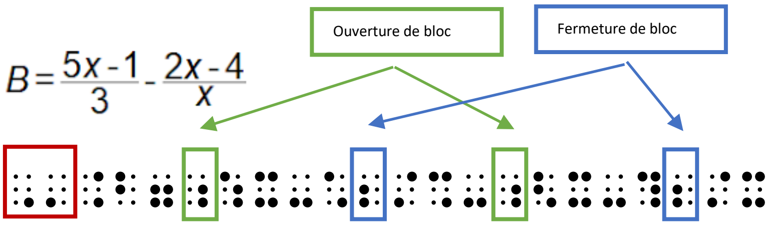
For students enrolled in inclusive schools, the specialist teacher in charge of pedagogical follow-up follows the progress of the host teacher when new concepts, mainly mathematics, are introduced, to prepare the student for the discovery of the new Braille code. It is possible to prepare individual sessions in mathematics to tackle different elements such as geometry, the use of a drawing board and Dycem sheets, reading and locating on graphs, reviewing the Braille code, etc.

The transcriber can also use a transcription note in the adapted document to alert the reader to the presence of new symbols, with an explanation.

Mathematical symbols are integrated into the school curriculum with the help of a specialized teacher. The disable student assistants ("Accompagnants d'Elèves en Situation de Handicap" AESH : https://www.education.gouv.fr/les-accompagnants-des-eleves-en-situation-de-handicap-12188) also plays a role in ensuring that the pupil uses the correct mathematical symbol when specialized software enables de-transcription, i.e. reading the Braille code in black.

## 4.2 Example of mathematical writing in 6-dot Braille with code details

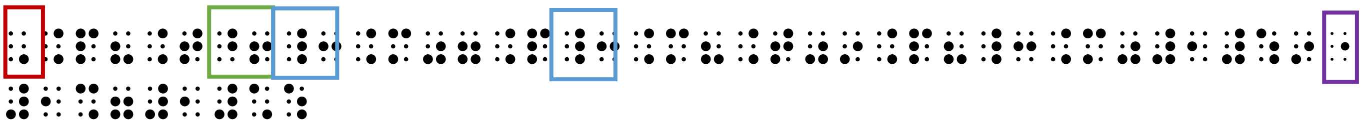
$$B=\frac{5x-1}{3}-\frac{2x-4}{x}$$




Soit en “noir” ▯ ‘'¨b»º5x-1;/3-º2x-4;/x

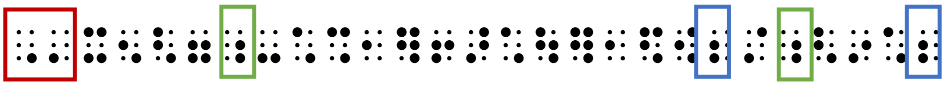
- Beginning of expression with dot 6 dot 3, announcing the use of blocks (red).
- Use of block opening and closing to delimit the 2 numerators.
  - Block opening points 56 (green)
  - Block closure point 23 (blue)
  -

$$P\left(T\cap\overline{M}\right)=P_{\overline{M}}(T)\times P\left(\overline{M}\right)=0{,}05\times 0{,}3=0{,}015$$



- Or in "black" □ "¨p(¨t²!¸:¨m)=¨p¸:¨m(¨t)*¨p(¸:¨m)=0.05*0.3=0.015
- Only a point 6 at the start of the expression, so no complex expression with blocks (red)
- Intersection symbol for point 45 and 235 (green)
- "Bar" symbol for the opposite point 456 and 25 (blue)
- Point 5 is an indicator, at the end of the line, to signal continuation of the expression on the next line (purple).

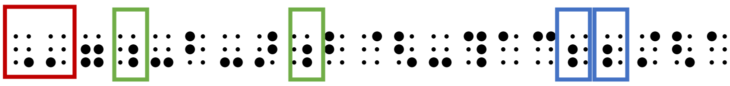
$$x_2 = \frac{-13,7+\sqrt{187,69}}{2\times -1}$$



Or in "black" ☐ ''x?2=º-13,7+@187,69;/º2*1;

- Beginning of expression with dot 6 dot 3 announcing the use of blocks (red)
- Use of block opening and closing to delimit the 2 numerators.
  - Block opening points 56 (green)
  - Block closure point 23 (blue)

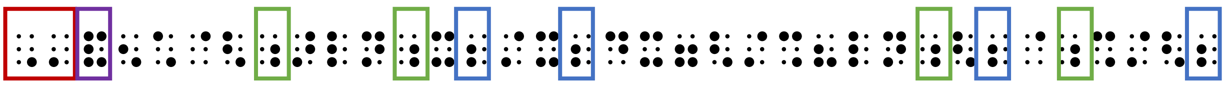
$$x' = \frac{-b-\sqrt{b^2-4ac}}{2a}$$



Or in "black" ☐ ''x'=º-b-@ºb^2-4ac;;/2a

- Beginning of expression with dot 6 dot 3 announcing the use of blocks (red)
- Use of block opening and closing to delimit the 2 numerators.
  - Block opening points 56 (green)
  - Block closure point 23 (blue)

$$\int_1^2 \frac{\sqrt{\ln x}}{x} dx = \frac{2}{3}(\ln 2)^{\frac{3}{2}}$$



Or in "black" ☐ ''ç?1^2º@lnºx;/x;dx=2/3(lnº2;^º3/2;

- Beginning of expression with dot 6 dot 3 announcing subsequent use of block (red)
- Use of block opening and closing to delimit the 2 numerators.
  - Block opening points 56 (green)
  - Block closure point 23 (blue)
- The integral sign represented by the letter "ç" ç (purple)

The appendix to this document contains the conversion table between the braille code used by Lambda and the French braille code.

# 5 Different tools for different class levels and teaching contexts

## 5.1 Tools for students

Different solutions are proposed for different class levels and teaching contexts. Early stimulation of visually impaired children is essential, and the more severe the visual impairment, the more important it is. This stimulation enables the child to seek out sensations and information through the various senses, but above all to develop touch and stimulate the desire to explore. Because of the child's age, a great deal of responsibility falls primarily on the family, who are supported by various specialized professionals (SAFEP, Psychomotrician, etc.). This enables the child's psychosensory-motor development, which is essential for future learning at school and in society. The more the child learns to explore and thus develop his or her sense of touch, the more meaningful it will be for tactile exploration of mathematical graphs and Braille.

## 5.2 At elementary school

Students work with a Perkins Braille machine which enables them to write Braille on paper.

*Figure 3 : Perkins machine*

The Perkins is used as soon as the student is able to press the keys, which can be "hard" due to the embossing of the sheet by the hammers. Its use in inclusive education requires the intervention of a specialized teacher, who comes to transcribe the documents produced by the student so that the teacher can read the productions. Being mechanical, this machine is rather noisy and imposing.

Cubarithms are small fixed cubes or cubes with three removable elements that can be used to perform operations, create conversion tables and create simple geometric figures.

*Figure 4 : cubarithmes*

A transition to the computer is made when the student has mastered full braille. The idea is for students to be able to take their own notes when they start secondary school. Thus, sessions to discover and use a Braille notepad or a computer and a Braille display are gradually introduced. There are several solutions on the market, including one that offers an all-in-one tool with a software suite enabling automated de-transcription of notes entered by the student.

## 5.3 Middle school

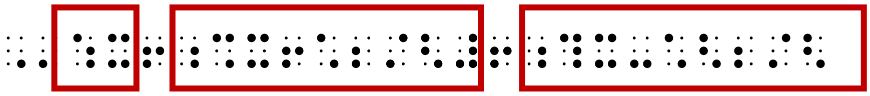
They continue to use paper Braille/Perkins Braille machines on an occasional basis, as well as cubarithms. The latter is gradually abandoned when the calculator is introduced.

Depending on the case, they use a stand-alone Braille system (Esytime Braille notepad, Bbook, Braille Sense) and some use a PC coupled with a Braille display. It is possible to add a screen reader (NVDA or Jaws) to use Windows in its entirety.

Mathematics software includes esysuite (Eurobraille's software suite) and BrailleMaths, which incorporates a calculator.

FIGURE 5 BLOC NOTE COUPLED WITH A COMPUTER

Mathematics and physics-chemistry remain complicated subjects for visually impaired students, and even more so for the blind. The Braille system is linear, which means that it is necessary to "translate" mathematical expressions, which can be complex, into a linear formula. So, as early as middle school, when working on the common denominator, the student goes from 5x+3x+120+4x-122 in black to the following



It immediately becomes more complicated for the disabled student not to be able to identify the members of this equation at a glance. He has to read it, understand it, and identify what he has at his fingertips. Then they understand that they need to find a common denominator, transform the different parts and reduce the equation as far as possible. Students use the technique that seems most appropriate to them:

Copy and paste the equation and process the whole equation at once to find the common denominator.

To process the members separately, line by line, and then put it all together.

## 5.4 High school

For high school, the tools are the same as for middle school, but they no longer use cubarithms and perkins.

Like mathematics, physics-chemistry uses visual representations that have a linear equivalence in Braille. For example, to represent a cyclic molecule, the chemical formula begins with the symbol __ and ends with -. As with mathematical braille, the student must learn, with the help of a specialized teacher, the specific coding to use chemical braille.

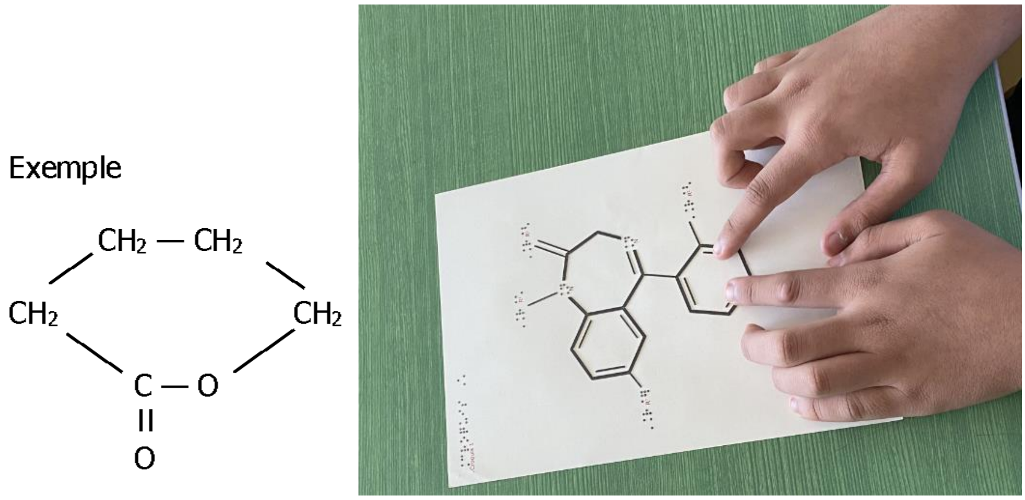



*Figure 10 : Chemistry*

⠤⠤⠲⠉⠲⠓⠣⠤⠲⠉⠲⠓⠣⠤⠲⠉⠲⠓⠣⠤⠲⠉⠲⠓⠣⠶

⠤⠲⠕⠤⠲⠉⠱⠻⠆⠲⠕⠣⠤

**Source**: Braille notation in the field of chemistry Document produced by the Commission for the evolution of French braille First edition June 2008

## 5.5 At the university

The tools used are those used in high school, some of which can also make more use of Latex notation, which is a linear notation and is widely used by teachers in higher education.

## 5.6 Tools for graphic representation

These tools are not sufficient for graphic representations, which are also represented in relief using several technical solutions. The most common solution is to use a special type of paper, known as thermo-inflated paper, which is passed through an oven to swell the parts printed in black.

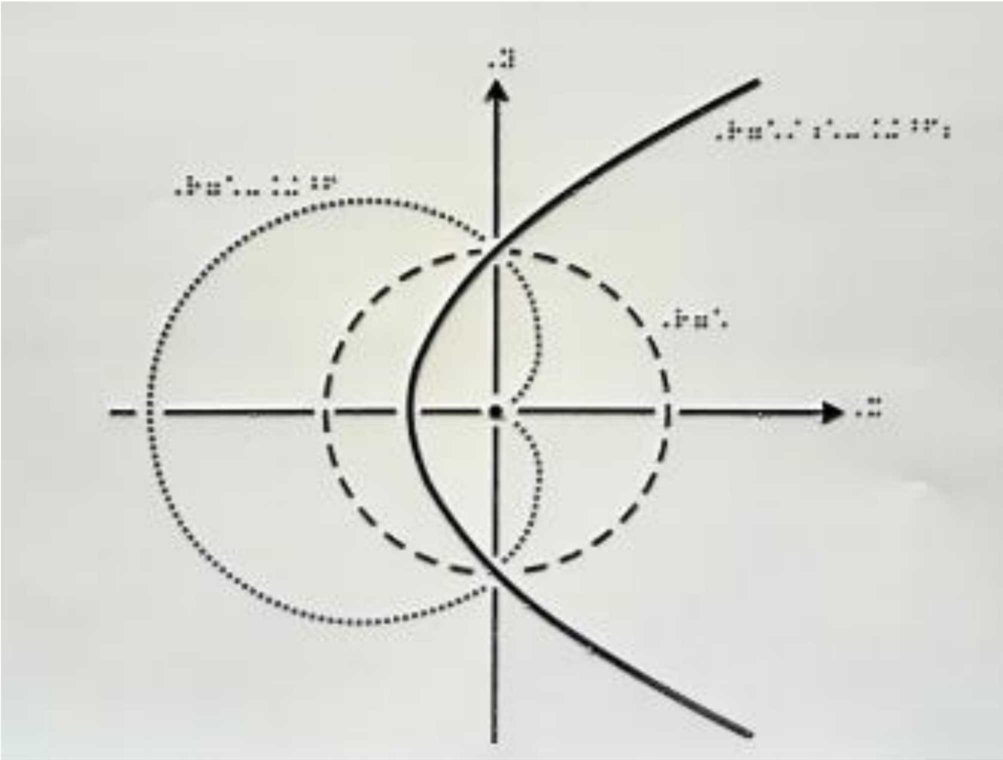


*Figure 11 schema on paper thermogonflé*

*Figure 12 planche dYcem*

*Figure 13 Tactipad*

Another tool that's coming out of use is the Dycem board, a flexible board combined with an anilox plastic sheet, which is embossed (this time directly on the front) using a ballpoint pen, for example.

*Figure 14 : utilisation d'outils pour geométrie*

Another possibility is to use guides like the tactipad.
Geometry learning can be facilitated by folding, as Pascal Aymard develops in his dissertation [2].

## 5.7 Tools for accessibility of block-based visual programming tools

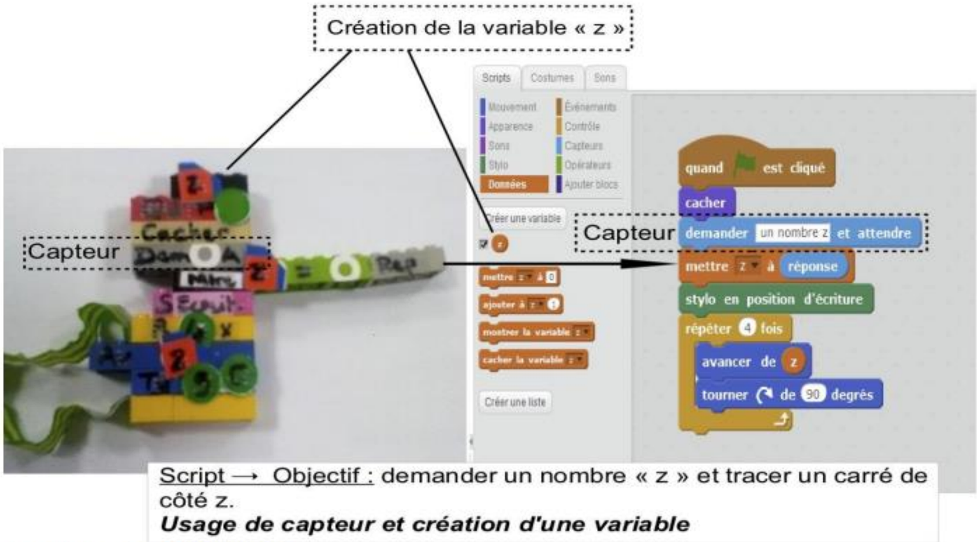
In France, **block-based visual programming tools** (such as the Scratch2 language) are used to introduce students to programming. It turns out that these tools are very difficult for blind people to access, which can lead to exemption from the algorithmic test on the Diplôme National du Brevet. Here, we describe the different solutions proposed by various researchers to make Scratch accessible to blind users. The various solutions propose to meet two objectives: firstly, to enable a blind student to write a program, and secondly, to make the result of the program thus created accessible. The use of physical blocks to be assembled meets the first objective, and can also encourage interaction between sighted and blind students since they can be easily used by a sighted person. The physical blocks can be identified by blind students through the use of a Braille inscription on each one. The program that has been physically built can either be copied into the machine by a sighted person, or automatically recognized by the machine. The result of the program produced by the student can either also be physically produced or carried out by a robot, or described orally to the user.

The main solutions proposed are :

**Accessi DV Scratch** [6] « unplugged Scratch in Braille with large print » was designed by Sandrine Boissel, teacher and coordinator of the ULIS for the visually impaired at Grenoble's Münch College.

The special feature of this solution is the use of assembled Lego bricks to represent the blocks. It uses a case with the various basic blocks and a tray for writing the program.

Source Image : Sandrine Boissel

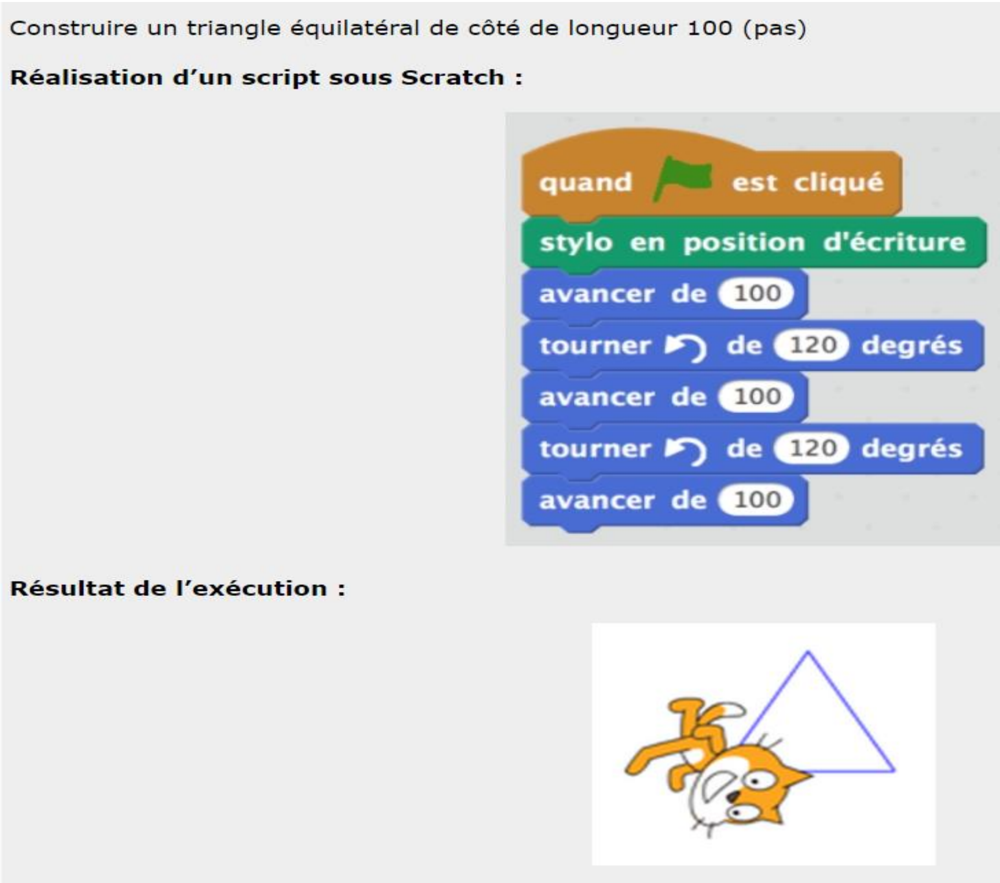



Source Image : Sandrine Boissel

*Figure 6 : Accessi DV Scratch*

**ALGORITHMIQUE, SCRATCH & CÉCITÉ...** [5] is an unplugged and adapted support resulting from a project piloted by Pascal Aymard, a mathematics teacher specializing (CAEGADV-2nd degree) in the accompaniment of visually impaired students.

The blocks are magnetized and positioned on a support comprising three spaces: one containing the blocks, a second in which the algorithm is constructed, and the third for describing the desired shape, which is the result of the algorithm.



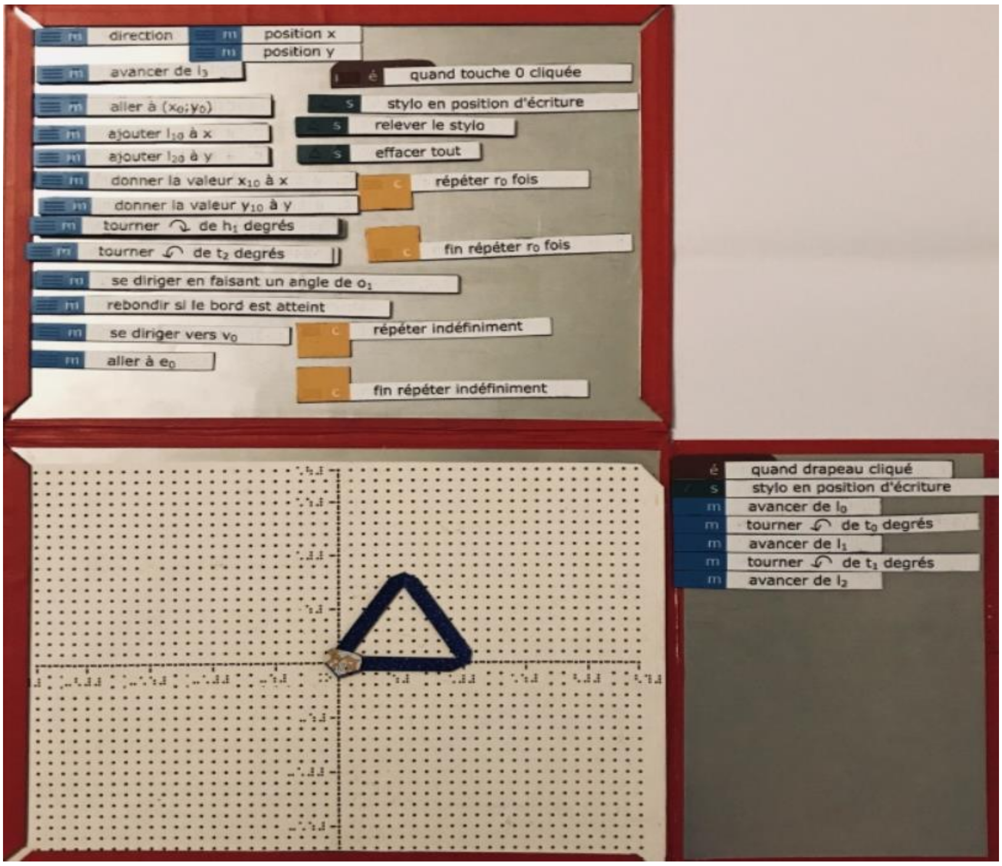



*Figure 7 : Scratch for blind students*

Institut national supérieur de formation et de recherche pour l'éducation des jeunes handicapés et les enseignements adaptés (National institute for training and research in the education of disabled young people and adapted teaching) proposes **Scratch 3D Magnet** [6].

This solution uses magnetized physical blocks that are positioned and assembled on a support to form the desired program.

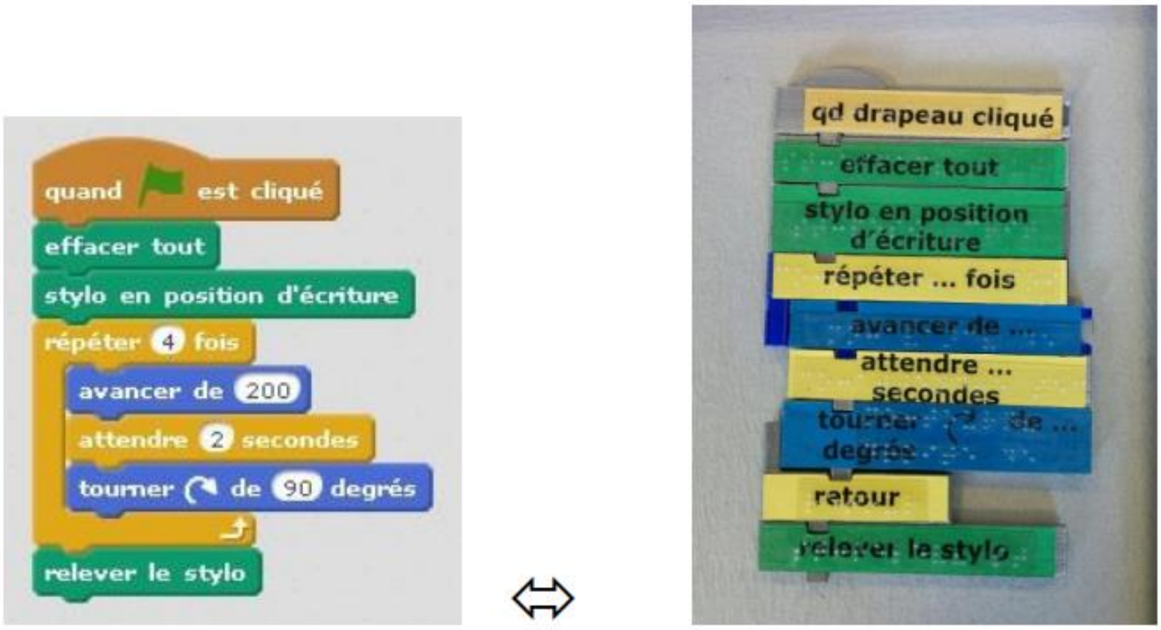



*Figure 8 : Scratch 3D Magnet*

**TabGO**:[8] Towards accessible computer science in secondary school was designed by a team of researchers at IRIT (Institut de recherche en Informatique de Toulouse).

The specificity of the solution proposed in this case is to use top codes so that the blocks and cubarithms used for the variables are recognized by the machine after the image has been taken, and to enable the graphic code to be generated automatically as described in the following process:

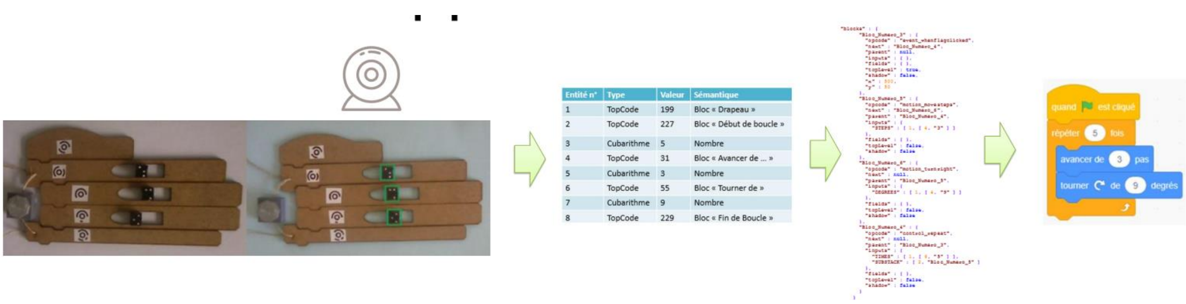


*Figure 9 : Tabgo process*

## 5.8 Tools for transcribers

To transcribe mathematics into Braille, adaptive transcribers use either Natbraille http ://natbraille.free.fr/ which is free software and can import a Mathml, odt, txt, docx file, but which presents a transcription interface with XML code, making it cumbersome to use.

Duxbury https://www.duxburysystems.com/ is also widely used, but requires a license.

# 6 Conclusion

This document gives a brief description of what is being done in France to enable visually impaired people to work on mathematics. As Nathalie Lewi-Dumont points out in her article [3], the various solutions proposed depend essentially on the student's level of impairment. Ms. Magna [4] also points out that "two people with the same disability, from a medical point of view, can have a totally different apprehension of the written word". This is why various solutions are proposed and specific training courses are available for carers. In addition, the difficulties associated with inclusion are alleviated by training all teachers to take account of pupils with special needs, as well as by training specialist teachers and transcribers to help pupils use accessibility tools to help them integrate into a standard classroom.

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# 8 Appendix : code-Braille-lambda-fr.pdf

| Nom Lambda | Symboles | Braille logiciel | Code Braille Logiciel | Code Braille FR 6 points | Braille FR 6points | Code Braille FR 8 points | Code Langue |
|---|---|---|---|---|---|---|---|
| apostrophe | ' | ⣿ ⡀ | 7 | 3 | ⠿ ⠄ | 3 | 5 |
| asterisk | * | ⣿ ⠔ | 35 | 5-35 | ⠿ ⠐⠔ | 35 | 5 |
| circumflex_accent | ^ | ⣿ ⠌ | 34 | 45-25 | ⠿ ⠘⠒ | 4 | 5 |
| comma | , | ⣿ ⠂ | 2 | 2 | ⠿ ⠂ | 2 | 5 |
| degree_sign | ° | ⣿ ⡢ | 267 | 5-135 | ⠿ ⠐⠕ | 267 | 5 |
| digit_eight | 8 | ⣿ ⠳ | 1256 | 1256 | ⠿ ⠳ | 1256 | 5 |
| digit_five | 5 | ⣿ ⠱ | 156 | 156 | ⠿ ⠱ | 156 | 5 |
| digit_four | 4 | ⣿ ⠹ | 1456 | 1456 | ⠿ ⠹ | 1456 | 5 |
| digit_nine | 9 | ⣿ ⠪ | 246 | 246 | ⠿ ⠪ | 246 | 5 |
| digit_one | 1 | ⣿ ⠡ | 16 | 16 | ⠿ ⠡ | 16 | 5 |
| digit_seven | 7 | ⣿ ⠻ | 12456 | 12456 | ⠿ ⠻ | 12456 | 5 |
| digit_six | 6 | ⣿ ⠫ | 1246 | 1246 | ⠿ ⠫ | 1246 | 5 |
| digit_three | 3 | ⣿ ⠩ | 146 | 146 | ⠿ ⠩ | 146 | 5 |
| digit_two | 2 | ⣿ ⠣ | 126 | 126 | ⠿ ⠣ | 126 | 5 |
| digit_zero | 0 | ⣿ ⠼ | 3456 | 3456 | ⠿ ⠼ | 3456 | 5 |
| division_sign | ÷ | ⣿ ⢤ | 368 | 25 | ⠿ ⠒ | 2578 | 5 |
| dollar_sign | $ | ⣿ ⢈ | 48 | 45-234 | ⠿ ⠘⠎ | 357 | 5 |
| equals_sign | = | ⣿ ⣶ | 235678 | 2346 | ⠿ ⠮ | 235678 | 5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| euro_sign | € | ⣿⢑ | 158 | 45-15 | ⠿⠘⠑ | 1578 | 5 |
| exclamation_mark | ! | ⣿⠖ | 235 | 235 | ⠿⠖ | 235 | 5 |
| full_stop | . | ⣿⠄ | 3 | 35-35 | ⠿⠔⠔ | 256 | 5 |
| greather_than_sign | > | ⣿⠘ | 45 | 5-345 | ⠿⠐⠜ | 567 | 5 |
| greek_capital_letter_theta | Θ | ⣿⡹ | 14567 | 46-45-245 | ⠿⠨⠘⠚ | | 5 |
| greek_small_letter_chi | χ | ⣿⠯ | 12346 | 45-12345 | ⠿⠘⠟ | | 5 |
| greek_small_letter_theta | θ | ⣿⠹ | 1456 | 45-235 | ⠿⠘⠖ | | 5 |
| hyphen_minus | - | ⣿⠤ | 36 | 36 | ⠿⠤ | 36 | 5 |
| lambda_alef | ℵ | ⣿⡳ | 12567 | 45-45-1 | ⠿⠘⠘⠁ | 12567 | 5 |
| lambda_and | ∧ | ⣿⡤ | 367 | 46-45-123 | ⠿⠨⠘⠇ | 367 | 5 |
| lambda_angle | ∟ | ⣿⡒ | 257 | | ⠿ | 257 | 5 |
| lambda_asterisk | ✱ | ⣿⢪ | 2468 | | ⠿ | 2468 | 5 |
| lambda_cartesian_product | × | ⣿⣒ | 2578 | 35 | ⠿⠔ | | 5 |
| lambda_circled_solidus | ⊘ | ⣿⡲ | 2567 | | ⠿ | | 5 |
| lambda_column_separator | , | ⣿⠂ | 2 | 2 | ⠿⠂ | | 5 |
| lambda_differential | ∂ | ⣿⢙ | 1458 | 46-1456 | ⠿⠨⠹ | | 5 |
| lambda_double_cross_bar | ǂ | ⣿⢆ | 238 | | ⠿ | | 5 |
| lambda_down_arrow | ↓ | ⣿⢇ | 1238 | 46-12456 | ⠿⠨⠻ | | 5 |
| lambda_empty_set | ∅ | ⣿⢕ | 1358 | 45-3456 | ⠿⠘⠼ | | 5 |
| lambda_exists | ∃ | ⣿⣹ | 145678 | 456-16 | ⠿⠸⠡ | | 5 |

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|---|---|---|---|---|
| lambda_expressions_separ | ; | 23 | 23 | 5 |
| lambda_forall | ∀ | 123458 | 456-34 | 5 |
| lambda_function_composi | ∘ | 38 | 456-3456 | 5 |
| lambda_generic_operator | ✱ | 2468 | | 5 |
| lambda_generic_tag | | 46 | | 5 |
| lambda_greek_tag | | 4 | 45 | 5 |
| lambda_hat | ^ | 34 | 45-25 | 5 |
| lambda_index_down | | 568 | 26-26 | 5 |
| lambda_index_down_left | | 268 | 6-26 | 5 |
| lambda_index_down_right | | 26 | 26 | 5 |
| lambda_index_up | | 456 | 4-4 | 5 |
| lambda_index_up_left | | 348 | 6-4 | 5 |
| lambda_index_up_right | | 3478 | 4 | 5 |
| lambda_infinity | ∞ | 578 | 45-14 | 5 |
| lambda_integer_part | L | 2378 | | 5 |
| lambda_integral | ∫ | 12346 | 12346 | 5 |
| lambda_intersection | ∩ | 35 | 45-235 | 5 |
| lambda_left_absolute_valu | \| | 1234568 | 123456 | 5 |
| lambda_left_angle_bracket | ⟨ | 3458 | | 5 |
| lambda_left_arrow | ← | 2348 | 456-246 | 5 |

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|---|---|---|---|---|---|---|
| lambda_left_binomial_coe | ( | ⣿⠦ | 236 | 236 | ⠿⠦ | |
| lambda_left_derivative | d̄ | ⣿⢙ | 1458 | 5-145 | ⠿⠐⠙ | |
| lambda_left_determinant | \| | ⣿⢸ | 4568 | 123456 | ⠿⠿ | |
| lambda_left_double_squar | ⟦ | ⣿⣄ | 378 | 46-12356 | ⠿⠨⠷ | |
| lambda_left_equation_syst | { | ⣿⣦ | 23678 | 46-236 | ⠿⠨⠦ | |
| lambda_left_flag | • | ⣿⠐ | 5 | | ⠿ | |
| lambda_left_fraction | // | ⣿⢦ | 2368 | 34 | ⠿⠌ | |
| lambda_left_inequations_t | [ | ⣿⢷ | 123568 | 12346 | ⠿⠯ | |
| lambda_left_matrix | ( | ⣿⠦ | 236 | 236 | ⠿⠦ | |
| lambda_left_partial_deriva | δ | ⣿⢹ | 14568 | | ⠿ | |
| lambda_left_power | ⇞ | ⣿⡌ | 347 | | ⠿ | |
| lambda_left_prime_factor_ | [ | ⣿⢷ | 123568 | 12346 | ⠿⠯ | |
| lambda_left_root | √ | ⣿⡜ | 3457 | 345 | ⠿⠜ | |
| lambda_left_ruffinis_rule_ | [ | ⣿⢷ | 123568 | 12346 | ⠿⠯ | |
| lambda_left_set_members | ∈ | ⣿⡦ | 2367 | 45-16 | ⠿⠘⠡ | |
| lambda_left_table | [ | ⣿⢷ | 123568 | 12346 | ⠿⠯ | |
| lambda_left_text | 🄰 | ⣿⡯ | 123467 | | ⠿ | 1258 |
| lambda_nabla | ∇ | ⣿⢝ | 13458 | 46-1456 | ⠿⠨⠹ | |
| lambda_not_tag | ⧄ | ⣿⡸ | 4567 | | ⠿ | |
| lambda_or | ∨ | ⣿⡔ | 357 | 45-26 | ⠿⠘⠢ | |

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|---|---|---|---|---|---|---|
| lambda_overscript | □̄ | ⣿ ⡄ | 37 | 456-25 | ⠿ ⠸⠒ | 5 |
| lambda_parallel | ‖ | ⣿ ⢳ | 12568 | 456-1256 | ⠿ ⠸⠳ | 5 |
| lambda_perpendicular | ⊥ | ⣿ ⣳ | 125678 | 45-1256 | ⠿ ⠘⠳ | 5 |
| lambda_proportional | ∝ | ⣿ ⢶ | 23568 | | ⠿ | 5 |
| lambda_repeating_decima | □̄ | ⣿ ⡄ | 37 | 456-25 | ⠿ ⠸⠒ | 5 |
| lambda_right_absolute_va | \| | ⣿ ⡿ | 1234567 | 123456 | ⠿ ⠿ | 5 |
| lambda_right_angle_brack | ⟩ | ⣿ ⡣ | 1267 | | ⠿ | 5 |
| lambda_right_arrow | → | ⣿ ⡱ | 1567 | 456-156 | ⠿ ⠸⠱ | 5 |
| lambda_right_binomial_co | ) | ⣿ ⠴ | 356 | 356 | ⠿ ⠴ | 5 |
| lambda_right_derivative | /∂ | ⣿ ⣲ | 25678 | | ⠿ | 5 |
| lambda_right_determinant | \| | ⣿ ⢸ | 4568 | | ⠿ | 5 |
| lambda_right_double_squa | ⟧ | ⣿ ⣠ | 678 | 46-23456 | ⠿ ⠨⠾ | 5 |
| lambda_right_equation_sy | } | ⣿ ⣴ | 35678 | 46-256 | ⠿ ⠨⠲ | 5 |
| lambda_right_flag | • | ⣿ ⠂ | 2 | | ⠿ | 5 |
| lambda_right_fraction | ⑊ | ⣿ ⡴ | 3567 | | ⠿ | 5 |
| lambda_right_inequations_ | ] | ⣿ ⢾ | 234568 | 23456 | ⠿ ⠾ | 5 |
| lambda_right_matrix | ) | ⣿ ⠴ | 356 | 356 | ⠿ ⠴ | 5 |
| lambda_right_partial_deriv | ∂̸ | ⣿ ⣲ | 25678 | | ⠿ | 5 |
| lambda_right_power | ↑ | ⣿ ⢡ | 168 | | ⠿ | 5 |
| lambda_right_prime_facto | ] | ⣿ ⢾ | 234568 | 23456 | ⠿ ⠾ | 5 |

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|---|---|---|---|---|---|---|---|---|
| lambda_right_root | ℽ | ⣿⢣ | 1268 | | ⠿ | | | 5 |
| lambda_right_ruffinis_rule | ] | ⣿⢾ | 234568 | 23456 | ⠿ | ⠾ | | 5 |
| lambda_right_set_member | ∋ | ⣿⢴ | 3568 | 46-45-16 | ⠿ | ⠨⠘⠡ | | 5 |
| lambda_right_table | ] | ⣿⢾ | 234568 | 23456 | ⠿ | ⠾ | | 5 |
| lambda_right_text | ⍁ | ⣿⡯ | 123467 | | ⠿ | | 123468 | 5 |
| lambda_row_separator | ; | ⣿⠆ | 23 | 23 | ⠿ | ⠆ | | 5 |
| lambda_scalar_product | × | ⣿⣒ | 2578 | 35-35 | ⠿ | ⠔⠔ | | 5 |
| lambda_set_tag | ⊡ | ⣿⠬ | 346 | | ⠿ | | | 5 |
| lambda_similar | ≈ | ⣿⠶ | 2356 | 5-2356 | ⠿ | ⠐⠶ | | 5 |
| lambda_square_root | √ | ⣿⠜ | 345 | 345 | ⠿ | ⠜ | | 5 |
| lambda_square_root_up | √ | ⣿⣀ | 78 | | | | | 5 |
| lambda_statistic_tag | ⎍ | ⣿⣎ | 23478 | | ⠿ | | | 5 |
| lambda_subset | ⊂ | ⣿⠰ | 56 | 46-16 | ⠿ | ⠨⠡ | | 5 |
| lambda_superset | ⊃ | ⣿⠘ | 45 | 5-16 | ⠿ | ⠐⠡ | | 5 |
| lambda_symmetric_differe | ⊖ | ⣿⡙ | 1457 | | ⠿ | | | 5 |
| lambda_underscript | ⍽ | ⣿⣘ | 4578 | 46-456-25 | ⠿ | ⠨⠸⠒ | | 5 |
| lambda_union | ∪ | ⣿⡖ | 2357 | 456-235 | ⠿ | ⠸⠖ | | 5 |
| lambda_up_arrow | ↑ | ⣿⢏ | 12348 | 45-12456 | ⠿ | ⠘⠻ | | 5 |
| lambda_vector | ⃗□ | ⣿⢒ | 258 | 46-25 | ⠿ | ⠨⠒ | | 5 |
| latin_capital_letter_a | A | ⣿⡁ | 17 | 46-1 | ⠿ | ⠨⠁ | 17 | 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| latin_capital_letter_b | B | ⣿ ⡃ | 127 | 46-12 | ⠿ | ⠨⠃ | 127 | 5 |
| latin_capital_letter_c | C | ⣿ ⡉ | 147 | 46-14 | ⠿ | ⠨⠉ | 147 | 5 |
| latin_capital_letter_d | D | ⣿ ⡙ | 1457 | 46-145 | ⠿ | ⠨⠙ | 1457 | 5 |
| latin_capital_letter_e | E | ⣿ ⡑ | 157 | 46-15 | ⠿ | ⠨⠑ | 157 | 5 |
| latin_capital_letter_f | F | ⣿ ⡋ | 1247 | 46-124 | ⠿ | ⠨⠋ | 1247 | 5 |
| latin_capital_letter_g | G | ⣿ ⡛ | 12457 | 46-1245 | ⠿ | ⠨⠛ | 12457 | 5 |
| latin_capital_letter_h | H | ⣿ ⡓ | 1257 | 46-125 | ⠿ | ⠨⠓ | 1257 | 5 |
| latin_capital_letter_i | I | ⣿ ⡊ | 247 | 46-24 | ⠿ | ⠨⠊ | 247 | 5 |
| latin_capital_letter_j | J | ⣿ ⡚ | 2457 | 46-245 | ⠿ | ⠨⠚ | 2457 | 5 |
| latin_capital_letter_k | K | ⣿ ⡅ | 137 | 46-13 | ⠿ | ⠨⠅ | 137 | 5 |
| latin_capital_letter_l | L | ⣿ ⡇ | 1237 | 46-123 | ⠿ | ⠨⠇ | 1237 | 5 |
| latin_capital_letter_m | M | ⣿ ⡍ | 1347 | 46-134 | ⠿ | ⠨⠍ | 1347 | 5 |
| latin_capital_letter_n | N | ⣿ ⡝ | 13457 | 46-1345 | ⠿ | ⠨⠝ | 13457 | 5 |
| latin_capital_letter_o | O | ⣿ ⡕ | 1357 | 46-135 | ⠿ | ⠨⠕ | 1357 | 5 |
| latin_capital_letter_p | P | ⣿ ⡏ | 12347 | 46-1234 | ⠿ | ⠨⠏ | 12347 | 5 |
| latin_capital_letter_q | Q | ⣿ ⡟ | 123457 | 46-12345 | ⠿ | ⠨⠟ | 123457 | 5 |
| latin_capital_letter_r | R | ⣿ ⡗ | 12357 | 46-1235 | ⠿ | ⠨⠗ | 12357 | 5 |
| latin_capital_letter_s | S | ⣿ ⡎ | 2347 | 46-234 | ⠿ | ⠨⠎ | 2347 | 5 |
| latin_capital_letter_t | T | ⣿ ⡞ | 23457 | 46-2345 | ⠿ | ⠨⠞ | 23457 | 5 |
| latin_capital_letter_u | U | ⣿ ⡥ | 1367 | 46-136 | ⠿ | ⠨⠥ | 1367 | 5 |

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|---|---|---|---|---|---|---|---|
| latin_capital_letter_v | V | ⣿⡧ | 12367 | 46-1236 | ⠿⠨⠧ | 12367 | 5 |
| latin_capital_letter_w | W | ⣿⡺ | 24567 | 46-2456 | ⠿⠨⠺ | 24567 | 5 |
| latin_capital_letter_x | X | ⣿⡭ | 13467 | 46-1346 | ⠿⠨⠭ | 13467 | 5 |
| latin_capital_letter_y | Y | ⣿⡽ | 134567 | 46-13456 | ⠿⠨⠽ | 134567 | 5 |
| latin_capital_letter_z | Z | ⣿⡵ | 13567 | 46-13567 | ⠿⠨⠵ | 13567 | 5 |
| latin_small_letter_a | a | ⣿⠁ | 1 | 1 | ⠿⠁ | 1 | 5 |
| latin_small_letter_b | b | ⣿⠃ | 12 | 12 | ⠿⠃ | 12 | 5 |
| latin_small_letter_c | c | ⣿⠉ | 14 | 14 | ⠿⠉ | 14 | 5 |
| latin_small_letter_d | d | ⣿⠙ | 145 | 145 | ⠿⠙ | 145 | 5 |
| latin_small_letter_e | e | ⣿⠑ | 15 | 15 | ⠿⠑ | 15 | 5 |
| latin_small_letter_f | f | ⣿⠋ | 124 | 124 | ⠿⠋ | 124 | 5 |
| latin_small_letter_g | g | ⣿⠛ | 1245 | 1245 | ⠿⠛ | 1245 | 5 |
| latin_small_letter_h | h | ⣿⠓ | 125 | 125 | ⠿⠓ | 125 | 5 |
| latin_small_letter_i | i | ⣿⠊ | 24 | 24 | ⠿⠊ | 24 | 5 |
| latin_small_letter_j | j | ⣿⠚ | 245 | 245 | ⠿⠚ | 245 | 5 |
| latin_small_letter_k | k | ⣿⠅ | 13 | 13 | ⠿⠅ | 13 | 5 |
| latin_small_letter_l | l | ⣿⠇ | 123 | 123 | ⠿⠇ | 123 | 5 |
| latin_small_letter_m | m | ⣿⠍ | 134 | 134 | ⠿⠍ | 134 | 5 |
| latin_small_letter_n | n | ⣿⠝ | 1345 | 1345 | ⠿⠝ | 1345 | 5 |
| latin_small_letter_o | o | ⣿⠕ | 135 | 135 | ⠿⠕ | 135 | 5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| latin_small_letter_p | p | ⣿ ⠏ | 1234 | 1234 | ⠿ ⠏ | 1234 | 5 |
| latin_small_letter_q | q | ⣿ ⠟ | 12345 | 12345 | ⠿ ⠟ | 12345 | 5 |
| latin_small_letter_r | r | ⣿ ⠗ | 1235 | 1235 | ⠿ ⠗ | 1235 | 5 |
| latin_small_letter_s | s | ⣿ ⠎ | 234 | 234 | ⠿ ⠎ | 234 | 5 |
| latin_small_letter_t | t | ⣿ ⠞ | 2345 | 2345 | ⠿ ⠞ | 2345 | 5 |
| latin_small_letter_u | u | ⣿ ⠥ | 136 | 136 | ⠿ ⠥ | 136 | 5 |
| latin_small_letter_v | v | ⣿ ⠧ | 1236 | 1236 | ⠿ ⠧ | 1236 | 5 |
| latin_small_letter_w | w | ⣿ ⠺ | 2456 | 2456 | ⠿ ⠺ | 2456 | 5 |
| latin_small_letter_x | x | ⣿ ⠭ | 1346 | 1346 | ⠿ ⠭ | 1346 | 5 |
| latin_small_letter_y | y | ⣿ ⠽ | 13456 | 13456 | ⠿ ⠽ | 13456 | 5 |
| latin_small_letter_z | z | ⣿ ⠵ | 1356 | 1356 | ⠿ ⠵ | 1356 | 5 |
| left_curly_bracket | { | ⣿ ⣦ | 23678 | 46-236 | ⠿ ⠨⠦ | 2378 | 5 |
| left_parenthesis | ( | ⣿ ⠦ | 236 | 236 | ⠿ ⠦ | 236 | 5 |
| left_square_bracket | [ | ⣿ ⢷ | 123568 | 12356 | ⠿ ⠷ | 23678 | 5 |
| less_than_sign | < | ⣿ ⠰ | 56 | 5-126 | ⠿ ⠐⠣ | 238 | 5 |
| multiplication_sign | × | ⣿ ⣒ | 2578 | 35 | ⠿ ⠔ | 3578 | 5 |
| not_sign | ¬ | ⣿ ⡸ | 4567 | | ⠿ | 2567 | 5 |
| per_mille_sign | ‰ | ⣿ ⣯ | 1234678 | 5-346-346 | ⠿ ⠐⠬⠬ | 34678 | 5 |
| percent_sign | % | ⣿ ⢯ | 123468 | 5-346 | ⠿ ⠐⠬ | 3468 | 5 |
| plus_sign | + | ⣿ ⡖ | 2357 | 235 | ⠿ ⠖ | 23578 | 5 |

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|---|---|---|---|---|---|---|---|
| right_curly_bracket | } | ⣿⣴ | 35678 | 46-256 | ⠿⠨⠲ | 5678 | 5 |
| right_parenthesis | ) | ⣿⠴ | 356 | 356 | ⠿⠴ | 356 | 5 |
| right_square_bracket | ] | ⣿⢾ | 234568 | 23456 | ⠿⠾ | 35678 | 5 |
| semicolon | ; | ⣿⠆ | 23 | 23 | ⠿⠆ | 23 | 5 |
| solidus | / | ⣿⠲ | 256 | 34 | ⠿⠌ | 34 | 5 |
| tilde | ~ | ⣿⠐ | 5 | 45-2356 | ⠿⠘⠶ | 38 | 5 |
| vertical_line | \| | ⣿⢸ | 4568 | 123456 | ⠿⠿ | 4568 | 5 |