

THIS IS ALL GREEK FOR ME

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ABSTRACT

Half a dozen problems for young mathematicians taken from the fields of linguistic and computer programming.

1. *Introduction*

This paper contains half a dozen problems involving basic logical thinking in contexts which are not normally seen as being mathematical. These problems cannot be called *core* problems of mathematics—but they give taste of a situation frequently encountered in a mathematician’s work: need to comprehend an uncomprehensible text—it could be a mathematical text in a foreign language, a technical manual, a computer code, fine print in an insurance policy, or a cipher.

One of more common stories told by mathematics graduates about their jobs is that on the first day in the office they had been given a manual for some business software system that no-one in the office was able to understand.

The ability to focus one’s attention on problem solving in an unfamiliar symbolic environment is an important part of a mathematician’s skills, and a few example here, taken from theoretical linguistics, computer programming, and cryptography, are selected as a taster.

The six problems supposed to make a chapter in a sequel to the book [†]. Unlike the book, the sequel focuses on problems essential for students who plan to study mathematics and computer science at university – and beyond.

Just a few days ago I discovered a fascinating case study of the use of cuneiforms in a secondary school lesson of information technology [‡].

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[†]Alexandre Borovik and Tony Gardiner, *The Essence of Mathematics Through Elementary Problems*. Open Book Publishers, 2019. ISBN Paperback: 9781783746996. ISBN Hardback: 9781783747009. ISBN Digital (PDF): 9781783747016 (pdf is free to download). DOI: 10.11647/OPB.0168.

[‡]I.A. Balabanova, *On problems in informatics shaping skills for the XXI century*. Paper presented at a conference *Topical problems of the methods of teaching informatics and mathematics in a modern school*, Moscow Pedagogical State University, Moscow, April 2021. (In Russian.)

2. Problems

- 1 The same mathematical text is presented in translations in several European languages. Translate the text back into English without using any dictionaries, etc.

Language A:

Setning. Hornin gagnstæð tveimur jöfnum hliðum í jafnarma þíhyrningi eru jöfn.

Sönnun. Látum ABC vera jafnarma þíhyrning með jöfnum hliðum AB og AC . Lítum nú á þíhyrningana ABC og ACB , þar sem litið er á þíhyrninginn ACB sem annan þíhyrning með hornpunktum A , C og B sem samsvara A , B og C í upprunalega þíhyrningnum. Hornið A er jafnt sjálfu sér, $AB = AC$ og $AC = AB$ svo samkvæmt hliðar-horns-hliðar skilyrðinu fyrir einsmótun, þá eru þíhyrningarnir ABC og ACB einsmóta. Sér í lagi er hornið B jafnt horninu C .

Language B:

Teorem. İkizkenar bir üçgende eşit kenarların karşısındaki açılar eşittir.

Kanıt. ABC , AB ve AC kenarları eşit olan ikizkenar bir üçgen olsun. ABC ve ACB üçgenlerine bakalım. Burada, ACB 'yi A , C , B köşeleri sırası ile orjinal üçgendeki A , B , C köşelerine karşılık gelen ikinci bir üçgen olarak göreceğiz. A açısı kendine eşittir, $AB = AC$ ve $AC = AB$, öyleyse kenar-açı-kenar kriterinden ABC ve ACB üçgenleri eşit. Özel olarak, B açısı C açısına eşittir.

Language C:

Teorema. Se um triângulo é isósceles, então os ângulos da base são iguais.

Demonstração. Seja ABC seja um triângulo isósceles, sendo A , B e C os seus vértices e AB e AC os lados iguais. Considere

um segundo triângulo $AB'C'$ com os vértices A , $B' = C$ e $C' = B$. Os triângulos ABC e $AB'C'$ são congruentes. Em particular o ângulo B é igual ao ângulo C .

- 2** Here are several dates in Swahili:

tarehe tatu Disemba jumamosi; tarehe pili Aprili jumanne; tarehe nne Aprili jumanne; tarehe tano Octoba jumapili; tarehe tano Octoba jumatatu; tarehe tano Octoba jumatano.

The translations in English are given in random order:

Monday 5 October; Tuesday 2 April; Wednesday 5 October;
Sunday 5 October; Saturday 3 December; Tuesday 4 April.

Write in Swahili: Wednesday 3 April; Sunday 2 December; Monday 1 November.

- 3** In Figure 1, you will find an excerpt from a book traditionally studied as part of GCSE in English and English Literature. The text was typeset using Grade 1 Braille Code. Read it without looking up tables of the Braille Code on the Internet.

HINT. The only one-letter words in English are *a* and *I*. The ten most frequent letters in English texts are

e, t, a, o, i, n, s, r, h, d.

- 4** [†] In 1916 the Estonian scholar Jacob Linzbach invented a universal writing system, which he thought should be understandable to all people, regardless of their native tongue. Linzbach called his new language ‘Transcendental Algebra’.

Several sentences have been written in Linzbach’s language and translated into English:

$$1. \left(\frac{\dot{\Delta} \ddot{\Delta} \dot{\Delta}}{\dot{\Delta} \dot{\Delta} \dot{\Delta}} + \frac{\dot{\Delta} \dot{\Delta}}{\dot{\Delta}} \right) ^{<}$$

$$2. \mathfrak{n}(> \dot{I})^{\mathbb{L}-t}$$

$$3. \left(\frac{\dot{\Delta} (-\dot{\Delta} \dot{\Delta})}{(-\dot{\Delta} \dot{\Delta})} \right)^{\mathfrak{E}} = \boxtimes$$

$$4. (-\mathfrak{n} \dot{I}_1)^{\mathfrak{E}} - t = \dot{I}_2$$

The father and the brother are talking.

The giants are working without haste.

The orphans are writing a letter.

It was not us who wrote about you (*singular*).

[†]First International Olympiad in Theoretical, Mathematical and Applied Linguistics, 8–12 September 2003, Borovetz, Bulgaria. Proposed by Xenia Guiliarova.

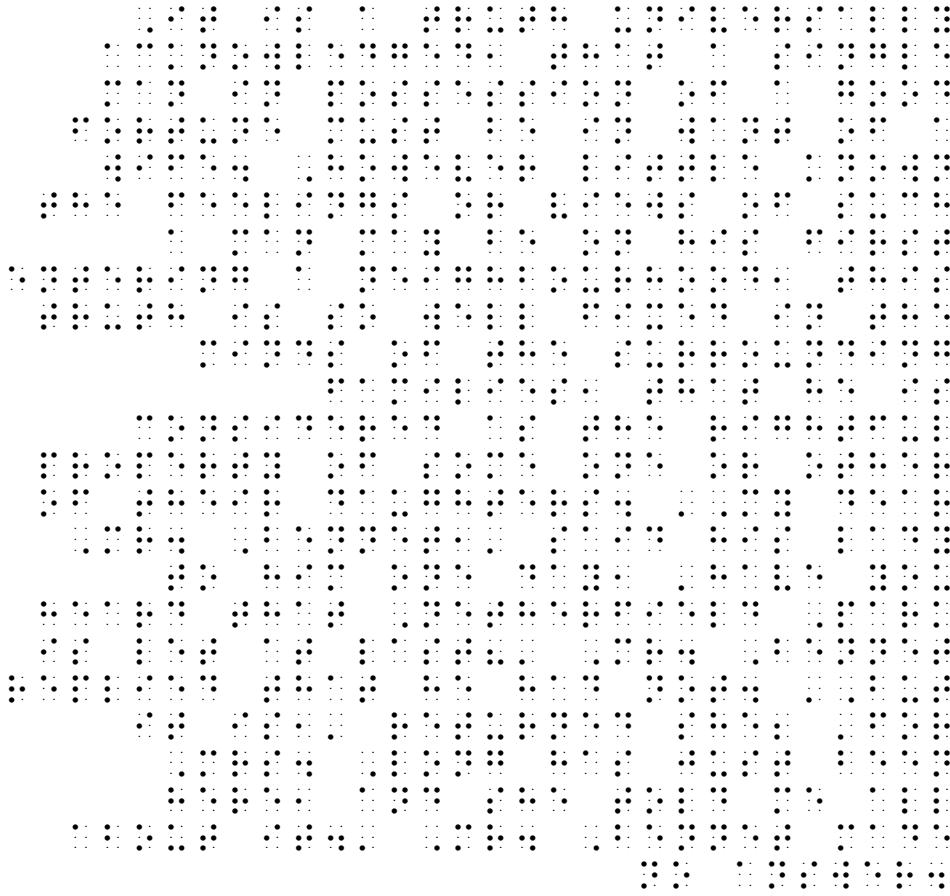


FIGURE 1. Braille text for Problem 3.

$$5. \blacksquare^{\sqrt{\heartsuit}} - t = -\dot{\Delta}_3$$

It was not by her that the letter
was written.

$$6. \left(\frac{\dot{\Lambda} \dot{\Delta} i \dot{\Delta}}{\dot{\Delta} i \dot{\Delta}} \right)^{-\heartsuit} = \square -$$

The father does not like work.

$$7. ((> i) - \heartsuit)^{\heartsuit} - t = \frac{\dot{\Lambda} \dot{\Delta} i \dot{\Delta}}{i \dot{\Delta}}$$

The wick giant ate the parents.

$$8. \dot{\Delta}_3^{-t}$$

She is not in hurry.

Translate into English:

$$9. i_3^{\heartsuit} - \sqrt{\heartsuit}$$

$$10. \left(\frac{\dot{\Lambda} \dot{\Delta} i \dot{\Delta}}{\dot{\Lambda} \dot{\Delta} i} - < \right)^{\heartsuit} + t = \frac{\dot{\Lambda} \dot{\Delta} i \dot{\Delta}}{\dot{\Delta} i \dot{\Delta}} + \frac{\dot{\Lambda} \dot{\Delta} i \dot{\Delta}}{\dot{\Lambda} i \dot{\Delta}}$$

$$11. \dot{\Delta}_2^{\square+t-<} - t$$

$$12. \ \blacksquare\sqrt{\blacksquare} - t = \frac{i\dot{\Delta}}{i} - \blacksquare$$

Write in ‘Transcendental Algebra’:

13. It was not about them that my husband and I (say: I and the husband) talked.
14. The people are working reluctantly.
15. The good widow loves the unemployed dwarf.
16. You (*plural*) will be talked about.

Explain your solution.

- 5** What follows is a formal description (a so-called “pseudocode”) of an algorithm which takes as an input a string of N numbers denoted

$$A(1), A(2), \dots, A(N).$$

```

For I = 1 to N - 1
  For J = 1 to N - 1
    If (A(J) > A(J + 1)
      Temp := A(J)
      A(J) := A(J + 1)
      A(J + 1) := Temp
    End-If
  End-For
End-For

```

What does the algorithm do with this string? What are the values of

$$A(1), A(2), \dots, A(N).$$

after the algorithm stops?

- 6** Another algorithm is written in a slightly different version of pseudocode.

```

Input: a, b % natural numbers
While a ≠ b
  If a > b
    a := a - b
  End-If
  Else
    b := b - a
  End-Else
End-While
Return a

```

What does it do?

3. Answers

Proof. Let ABC be an isosceles triangle with $AB = AC$. In particular angle B is equal to angle C . By construction of congruence, triangles ABC and ACB are congruent. So by the side-angle-side criterion, $AB = AC$ and $AC = AB$, so angle A is equal to itself, and C in the original triangle. Angle A is equal to vertices A , C and B corresponding respectively to A , B and C in the original triangle. Consider the triangles ABC and ACB , where ACB is considered a second triangle with being the equal sides. Consider the triangles ABC and ACB , where ACB is considered a second triangle with vertices A , C and B corresponding respectively to A , B and C in the original triangle. Angle A is equal to angle C .

Theorem. The angles opposite the two equal sides of an isosceles triangle are equal.

1 Answer. This is an English version of the text.

most Novembaja jumatau.

2 Answer. If you think that it is impossible, here is the answer to the last one: tarehe

3 Answer. It is a truth universally acknowledged ...

4 Answer. Skipped – too messy to type. These symbols were designed for handwriting.

5 Answer. The algorithm reorders the values in the string in the non-decreasing order:

6 Answer. The algorithm returns the greatest common divisor of a and b .

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Disclaimer

The author writes in his personal capacity and the views expressed do not necessarily represent the position of his (former or current) employer(s) or any other person, corporation, organisation, or institution.

About me

I am a research mathematician but I have 40+ years of teaching experience at secondary school and university level in four different countries with four different education systems; since 1998 I was a Professor of Pure Mathematics at the University of Manchester, currently I am a retired Professor Emeritus.

I also have an interest in cognitive aspects of mathematical practice; see my book Mathematics under the Microscope [†], which explains a mathematician's outlook at psycho-physiological and cognitive issues in mathematics and mathematics education, and touches on some issues raised in this paper. Some of my papers on mathematics education can be found in my personal online journal/blog *Selected Passages From Correspondence With Friends* [‡].

[†]A. V. Borovik, *Mathematics under the Microscope: Notes on Cognitive Aspects of Mathematical Practice*. Amer. Math. Soc., Providence, RI. 317 pp. ISBN-10: 0-8218-4761-9. ISBN-13: 978-0-8218-4761-9. Available from the [AMS](#).

[‡][Selected Passages From Correspondence With Friends](#). ISSN 2054-7145.