PRESIDENTIAL ESSAY NO. 9: DECEMBER 2021

Lost in Translation: Mathematics and Language

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Day in and day out mathematics is explained via the spoken word, but also through the medium of printed text. The extent to which mathematics and language impinge on each other is quite considerable. Do they have the same domain, do they run in parallel or are there points of contact? This is an exploration of mathematics and language, from an initial plea that we set a good example when using language and correct pupils' poor English (or other language, where appropriate), to some ideas for enhancing mathematics in the classroom through the use of various mathematics-language analogues.

For many years, mathematics teachers (and teachers of other subjects) paid only passing attention to grammar, spelling and punctuation unless any failing on the part of the pupil impacted on their own subject. For example, the correct spelling of mathematical terms would be actively encouraged by mathematics teachers. Now there is a feeling that mathematics teachers should take a more active role in language, and that we should support pupils' understanding in any area of the curriculum in which we have relevant competence, language included.

The English language is in a state of flux and so it must be. All things must pass and all things must develop. The use of the latest technology is having an influence and it's neither all bad nor particularly original. Having to pare language to the bone, youngsters are engaged in something akin to expressing mathematical relationships in symbols, IMHO. But it is far from novel, as demonstrated by this play on words from James Clerk Maxwell to Peter Guthrie Tait (in a letter of 1871):

R. U. AT 'OME?

On one level it asks a question about Tait's whereabouts, yet it is really praising Tait for being all-knowing on the issue they were then debating.

Of course, for some time, we have been aware of the American media having a major effect on language in Britain. Some of the ways in which English is being mangled have become so commonplace that they go without thought or comment. Take, for example, the near loss of the word 'are' in favour of 'is', regardless of the number of things being discussed, the pronunciation of the verb 'to harass' where the emphasis should be on the first syllable, the use of 'obligated' rather than 'obliged' of 'stand-out' instead of 'outstanding', of counterclockwise instead of anticlockwise, and of calls by pupils (or is it 'students'?) to go to the 'restroom' or the 'bathroom'.

Enough of the moans, let us consider what we might be doing and what we should be doing.

Intonation and speech pattern

A teacher's intonation patterns are peculiar to that individual but reflect parental and regional influences. Whilst it is important that such variety exists, we need to ensure that not only is our delivery clear but that it is replete with tonal colour. A flat delivery is not simply boring for the class but suggests the teacher is not interested in the mathematics being delivered, a fatal flaw when it comes to generating interest among pupils.

As a contribution to multisensory learning, mathematics teachers can 'speak' algebra. This added dimension to what is being taken in by the eyes may make all the difference for some youngsters. For example, if pupils are struggling to understand the difference between $5x^2$ and $(5x)^2$, then enunciate them as: "five ... x squared" and "five x ... squared" as appropriate. When teaching the distributive law, try writing

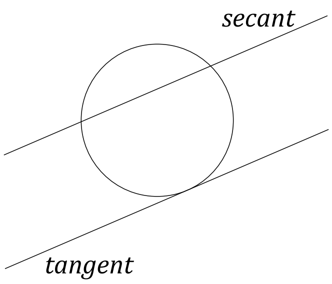
$$3(2t+8) = 6t + 24$$

on the board, standing to the side and, facing the class (the symbols out of sight), saying "three lots of two t plus eight is six t plus twenty-four". With practice, it's possible to deal with pairs of brackets such as, "two x plus three lots of six x minus one is two x lots of six x minus one plus three lots of six x minus one". (One or two jaws will drop!) Perhaps the teacher could speak such algebra (in dictation fashion) and the pupils could be asked to write it down.

Etymology and understanding concepts

Etymology is the study of the history and derivation of words. Having a grasp of the etymology of mathematical terms can help children to understand the concepts they represent. Here are just five examples:

- *isosceles* is derived from the Greek for 'equal legs';
- *tangent* is from the Latin 'to touch' (we see it in the 'touching dance', the *tango*, and in *tangible*);



- *section*, as in cross-*section* and *bisection*, is from the Latin 'to cut' (to *section* something is to cut it up, a Caesarian *section* is a cut into the womb to release a baby): also a *secant* is a line slicing right through a curve, usually a circle;
- *surd* is the name given in ancient times to measurements that were 'absurd' or illogical, including the length of the hypotenuse of an isosceles right triangle (a multiple of $\sqrt{2}$); measureable lengths are quite the opposite, *rational* or logical;
- *perimeter* is the measurement around something (*peri*- is around in Greek, as in *periscope*, *meter* is to measure).

Incidentally, ISOSCELES appears in every list of misspelled words, both for frequency of misspelling and the number of variations. The following mnemonic may help pupils reach the correct spelling:

> I sat on seagull's cliff,
> eating lumpy egg sandwiches.

There are many more mathematical terms to explore etymologically; so let the adventure begin...

Two mathematical terms with an interesting cultural derivation are *algebra* and *algorithm*. Like many other words beginning with *al*- (such as *alcohol*, *alkali* and the *Alhambra*), they are Arabic in origin. In fact, the word *algorithm* comes from the name of the Baghdadi mathematician and astronomer Muhammad ibn Mūsā al-Khwārizmī, who lived around 800 CE. His most important mathematical work, *Hisāb al-Jabr w'al-muqābala* contains the word *algebra* in its title and the main purpose to which al-Khwārizmī puts his algebra is the solution of quadratic equations.

Numerous mathematical words include *gon*, which comes from the Greek for a corner or angle. (Our word *knee* has the same origin.) There is *polygon* ('many angled') and several specific members of the family, from *pentagon* to *dodecagon* and beyond. The overwhelming majority of the number prefixes, *penta*-, *hexa*-, *hepta*-, *octa*-, *deca*-, *hendeca*- and *dodeca*- are Greek, making the polygon names pure Greek. Meanwhile, *triangle* is pure Latin. However, *nonagon* is problematic, in that it has one Latin and one Greek syllable. Purists insist on *enneagon* for a nine-sided polygon (both syllables being Greek). (I well remember, John Rigby pulling me up for using *nonagon*!) We should not forget *trigonometry*, which means 'three angle measurement', but that also leads us to other words that feature measurement in their etymology.

These days, we use the *metric* system of measurement, which has the *metre* as its primary unit of length. We shall come to the sub- and super-units presently but not before alluding to *geometry* or 'earth measurement' and the circle's *diameter* which is found by 'measuring across'. Further examples include numerous scientific subdisciplines, such as *optometry* and *telemetry*, and of course, *perimeter*, already mentioned.

Rather interesting are the SI prefixes used to multiply standard units by powers of 10. Mathematics teachers use a small number of them frequently, whilst our science colleagues make use of many more:

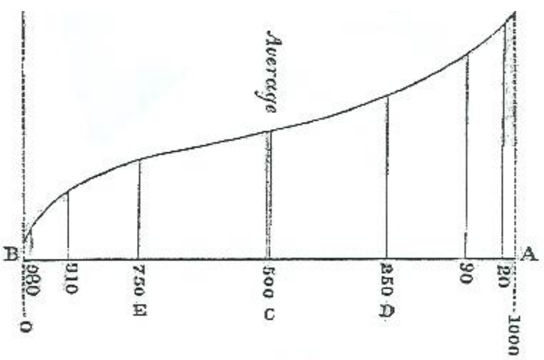
Prefix	Power of 10	Prefix	Power of 10
deca-	1	*deci-*	-1
hecto-	2	*centi-*	-2
kilo-	3	*milli-*	-3
mega-	6	*micro-*	-6
giga-	9	*nano-*	-9
tera-	12	*pico-*	-12
peta-	15	*femto-*	-15
exa-	18	*atto-*	-18
zetta-	21	*zepto-*	-21
yotta-	24	*yocto-*	-24

All the prefixes used for the positive powers are Greek: *deca*-, *hecto*- and *kilo*- are simply Greek for 10, 100 and 1000; *mega*- and *giga*- are Greek for 'great' and 'giant'; *tera*- and *peta*- are effectively the Greek numbers *tetra* and *penta* with a letter dropped; *exa-* is a variant of *hexa-*, Greek for six, since $10^{18} = 1000^6$; *zetta-* and *yotta-* are derived from the Greek letter *zeta* and the Greek for eight, *okto*.

Meanwhile, the prefixes used for the negative powers begin in pure Latin but then wander elsewhere: *deci-, centi-* and *milli-* are Latin for 10, 100 and 1000, and *micro-* is Latin for 'small'; *nano-* is Greek for 'dwarf'; *pico-* is Spanish for a 'bit', *femto-* and *atto-* come from the Danish *femten* (15) and *atten* (18) because they represent 10^{-15} and 10^{-18}.

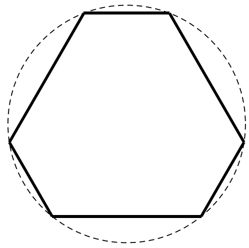
All this may be thought a little esoteric, but let me give an example of the use of one of the prefixes we use rarely in Britain, namely *hecto-*. When I was in Stockholm some years back I noticed that in Sweden (and perhaps in many other countries for all I know), they use the *hectogram* rather than the *kilogram* for selling produce such as fresh fruit.

There are several mathematical terms with graph or the etymologically equivalent gram included. Graphs are themselves pictures or drawings, a parallelogram is a figure drawn using two pairs of parallel lines; a pictogram represents data by drawing in pictures whilst the histogram, given its name by the statistician Karl Pearson, is a diminutive of 'historical diagram'. I cannot leave the domain of statistical diagrams without mentioning the ogive. The name of this cumulative frequency curve is derived from the French *augive* which tells us that the correct pronunciation must be 'ojiv'. An augive or ogee is a term in architecture for the diagonal rib of a vault. Here we see crossing strainer arches in Wells Cathedral in classic ogee fashion. And here is the very first ogive, published by Francis Galton in 1874:



The thing to notice here is that the curve depicted is not the *ogive* we have today but the curve of its inverse and hence a reflection in a sloping line.

The word *lateral* comes from the Latin for 'side'. We see it in *equilateral* (having equal sides), *quadrilateral* (four-sided), *bilateral symmetry* (two-sided symmetry arising from reflection). Care should be taken when using *equilateral* in geometry; it can be conflated with *equiangular* (having equal angles) and *regular* (effectively, having rotational symmetry). There is no ambiguity in the term *equilateral triangle* because *equiangularity* is also present. However, when it comes to other polygons, this is not the case. Here's an equiangular hexagon, produced by shaving an equilateral triangle:



Ask your pupils if they can think of a quadrilateral that is *equilateral* but not *equiangular*, or one that is *equiangular* but not *equilateral*?

The language of countability

There was a news item a few years ago about signs in Tesco stores. In their attempt to fast-track customers with hand-baskets only, the supermarket chain had been using signs which read, "10 items or less". Though pressed to substitute the correct phrase, "10 items or fewer", Tesco opted to play safe and avoid confusion by changing to "Up to 10 items".

The issue here is related to the mathematical concept of countability. *Less* means 'not as much' while *fewer* means 'not as many'. So we should use *fewer* when referring to items that can be counted individually. By the same token, we should say *more* sand or a smaller amount of water but a *greater number* of buckets to carry them in. Of course care should be taken with the use of the symbols < and >, which are always read 'less than' and 'greater than', regardless of the countability or measurability of the material under consideration. And be aware that where we in mathematics depart from this general advice altogether, a computer's autocorrection may well kick in, with *method of least squares* being 'corrected' to *method of fewest squares*.

Verbs (operators) and nouns (numbers)

Mathematics is a very exacting discipline, with little room for manoeuvre. If it were not so, the whole edifice would fall apart. (In some sense it did actually fall apart with Kurt Gödel's exposure of the circularity of Bertrand Russell's arguments, but let's not go there!) But in using the same symbol for a negative quantity and the operation of subtraction, we have created a looseness that impacts on learning mathematics. We might use a short, sharp hyphen, -, or even an elevated hyphen, ⁻, for a negative number, and possibly an 'en dash', –, to indicate subtraction, but it's all a little unsatisfactory.

However, there are parallels in language which might help here. We can stress that **numbers** are objects, linguistically **nouns**, whilst **subtracting** is an operation, linguistically a **verb**. Negative numbers are things, subtraction is something done to them. It is standard practice in Scottish schools to refer to a number such as -9 as 'negative nine', and this is far better than the commonly used 'minus nine' used by teachers in England (despite this being consistent with temperatures given in weather forecasts). Some teachers explain that (whole) numbers are staging posts (noun) on a number line and that subtracting is a movement (verb describing some action) in a particular direction between such numbers. It all ends up with soldiers marching up and down facing this way and that, but it can work well.

My preference is for negative numbers to be considered as debts (noun) and positive numbers as amounts of money in a pocket or purse. Subtraction becomes the process of 'removing' (verb). This gives me a sporting chance of persuading a class that subtracting a negative quantity is effectively adding. Referring to a particular member of the class, I say:

> *Imagine that John owes me £2. Being in a particularly generous frame of mind, I turn to him and say, "John, you know that £2 you owe me ... just forget about it." At that moment, does he frown or does he smile? Yes, he smiles, and that can only be because his finances have improved; hence addition.*

Removing or cancelling a debt is advantageous to the debtor; subtracting a negative quantity is a positive move.

Pythagoras and his apostrophe

The apostrophe continues to have a hard time, misused by pupils and plenty of teachers. The standard way of teaching the apostrophe is to divide its use into two cases. We have the *pupil's homework* if we are talking about the homework of one pupil, or the *pupils' homework* if we are talking about the homework of a whole group of pupils ($n > 2$). The third case, in which only the apostrophe is used in conjunction with the name, is rarely discussed. For us, the classic example is Pythagoras' Theorem.

Many names end with the letter 's', including that of Pythagoras. Where the person is someone from the far distant past, from ancient Greece, say, then just an apostrophe is used at the end of the name, but if it is someone from any other era and especially from the present or near past, an apostrophe and an extra 's' may be used. So we should write Bayes's Theorem (even if we say *Bayes Theorem*). It's complicated, but let us as least get the spelling of Pythagoras' Theorem correct. If that's too much to ask, then perhaps we should move over to the American version, the Pythagorean Theorem. I hope not!

The structure of counting words

The way that different peoples count in their own languages is fascinating. Their number words reflect the base in which their system operates. In Britain (for the most part), we use a base 10 system of counting (called *decimal* or *denary*) and that is signalled by the English words we use for our numbers. But there are other systems that pivot on 5 or 20, and some even stranger concoctions.

In our system, by and large, numbers above ten are given in terms of a number of tens plus a number of units. For example, twenty-six means 'two tens and six' or 2 × 10 + 6. [Of course, 11 and 12 are quirky in this system. *Eleven* is derived from the Germanic compound, *ainlif*, meaning 'one left' (after a group of ten has been removed). Similarly, *twelve* comes from *twalif* or two left over on removing ten. Equivalent words for 11 and 12 are seen in numerous languages influenced heavily by early German, including Danish and Lithuanian. In fact, Lithuanian is the only language which continues the 'left over' arrangement right through to 19.]

Returning to number words in English, we must not forget the *dozen*, derived from the French *douzaine*, meaning a group of twelve and celebrated and retained for its overabundance of divisors. And then there's the *baker's dozen* of 13. The derivation of this term is sometimes explained in the following way. The baker would get into a rhythm of making loaves or rolls of the same size but this would often leave a small piece of the prepared dough and so a small extra one would be thrown in rather than waste it. Actually, the practice was not an act of munificence but a way of ensuring that the customer was not given 'short measures', the punishment in English Law (going back centuries) being amputation of the very hand that proffered the unduly light goods.

There are numerous alternatives to a base 10 system of counting, each revealing its base through the structure of its number words. Here is a particularly unusual example:

1 *sas*
2 *thef*
3 *ithin*
4 *thonith*
5 *meregh*
6 *mer*
7 *mer abo sas*
8 *mer abo thef*
9 *mer abo ithin*
10 *mer abo thonith*
11 *mer abo meregh*
12 *mer an thef*
13 *mer an thef abo sas*
.
18 *tondor*
.
25 *tondor abo mer abo sas*
.
36 *nif*
.
77 *nif thef abo meregh*

These counting words come from the Ndom language, spoken by perhaps a few hundred people on the Indonesian island of Palau Yos Sudarso. In their system, the main pivot is clearly at 6, with further pivots at 18 and 36; so it is a base 6 or *senary* system. Can you predict what 89 is in Ndom?

I have a soft spot for *vigesimal* systems in which counting is in twenties. There are vast tracts of the world in which such systems have flourished from Georgia to Bhutan, from Nigeria to the Celtic fringe of Europe, and from the ancient Mayan peoples of Central America to rustic, rural Albania.

Along the western margins of Europe, peoples have traditionally counted in twenties, from the Basque language of *Euskara*, through Breton, Welsh and Irish, and on to the *Scots Gaelic* of the Highlands and Islands. I was raised in Wales and learnt the vigesimal system on the left, in the table below. It's a very quirky counting system, pivoting quite clearly on 20 but with minor pivots on 10 and 15 and that crazy 'two nines' for 18. In a push to promote the Welsh language in the 1960s and 1970s through Welsh medium nursery and primary schooling, a simpler decimal system was instituted (on the right in the table). Exactly the same process has taken place more recently with Gaelic.

Number	Welsh (vigesimal)		Welsh (decimal)	
11	un ar ddeg	1 + 10	undeg un	1 × 10 + 1
12	deuddeg	2 (+) 10	undeg dau	1 × 10 + 2
13	tri ar ddeg	3 + 10	undeg tri	1 × 10 + 3
14	pedwar ar ddeg	4 + 10	undeg pedwar	1 × 10 + 4
15	pymtheg	5 (+) 10	undeg pump	1 × 10 + 5
16	un ar bymtheg	1 + [5 (+) 10]	undeg chwech	1 × 10 + 6
17	dau ar bymtheg	2 + [5 (+) 10]	undeg saith	1 × 10 + 7
18	deunaw	2 × 9	undeg with	1 × 10 + 8
19	pedwar ar bymtheg	4 + [5 (+) 10]	undeg naw	1 × 10 + 9
20	ugain	20	dauddeg	2 × 10
21	un ar hugain	1 + 20	dauddeg un	2 × 10 + 1
22	dau ar hugain	2 + 20	dauddeg dau	2 × 10 + 2
23	tri ar hugain	3 + 20	dauddeg tri	2 × 10 + 3
30	deg ar hugain	10 + 20	trideg	3 × 10
40	deugain	2 × 20	pedwardeg	4 × 10
50	hanner cant	½ × 100	pumdeg	5 × 10
60	trigain	3 × 20	chwedeg	6 × 10
70	deg a thrigain	3 × 20 + 10	saithdeg	7 × 10

Counting in Welsh (then and now)

The French system of counting is part vigesimal, notably in the range 60 to 99, for example *quatre-vingts* (4 × 20) for 80. In the Middle Ages, counting in twenties extended to *dix-huit-vingts* (18 × 20 = 360), especially in coastal regions where Celtic influences were strongest, but reform of the system into the decimal-vigesimal mish-mash it is today was instituted following the French Revolution. Interestingly, in Belgian French, *septante* and *nonante* are used for 70 and 90. This is also the case in Swiss French, where in addition, *huitante* is used for 80 in some cantons.

Finally, there is no more dogmatic vigesimal system than that used by the Danes. Up to 19, this system provides no surprises, pivoting on 10 as in many systems (with the exception of 11 and 12, as noted already). Twenty is *tyve*, and 40, 60 and 80 are effectively 2, 3 and 4 twenties. The quirkiness is to be found in between. For 50 we have *halvtreds*, meaning 'third half times twenty'; similarly 70 is *halvfjerdsindstyve*, which means 'fourth half times twenty' and 90 is *halvfemsindstyve* or 'fifth half times twenty'. The logic is that the first half is ½, the second half is 1½, the third half 2½ and so on. There are other vigesimal systems which express 90 as $4 \times 20 + 10$ but no other which express this number as 4½ × 20. More details are at: www.sf.airnet.ne.jp/ts/language/number/danish.html

Etymology of ordinals

Of the Greek ordinal prefixes we use only proto- and deutero- (as in prototype; deuterotype and Deuteronomy). In the main we use the Latin, the first two ordinals being the most fascinating. *Primus* means 'first' but is itself derived from *pro* (as in the *pre*- in prefix, i.e. meaning 'before'). *Secundus* means 'second' but it comes from the verb 'to follow', *sequor*. There is a sense then, that our *prime* or *primary* means 'before the second' and our *second* or *secondary* means 'after the first'. Clearly, our 'sequence' is also related to *sequor* and hence to 'second' and to 'sequel'; so it is really about numbers following one another.

Our word 'third' comes via early Germanic languages, by way of 'thrid' (which was more common than 'third' until about 400 years ago. The division of Yorkshire into 'ridings' or (th)ridings (third parts) follows the same route of language development.

Latin also has 'distributives', the first four relating to ordinals being *singuli*, *bini*, *terni*, and *quaterni*. They are retained in words such as 'single', 'bicycle', in our number bases (binary, ternary and quaternary) and in the geological periods (Ternary and Quaternary).

Towards the esoteric

In the remaining sections, we explore some rather esoteric links between mathematics and language. We begin by reversing the order of letters in a word and the digits in a number. I call asymmetrical cases 'reversals', with 'palindromes' and 'palindromic numbers' reserved for the symmetrical. Then we continue on through acronyms, bacronyms and mnemonics to cryptarithms, snakes and ladders and anagrams.

Reversals

There are some words in English which when reversed turn into another word. Examples include: (animal, lamina), (desserts, stressed), (redraw, warder). In a sense, all numbers can be reversed to give other numbers, though we may frown at (2190, 0912) because, typically, we don't begin numbers with a zero. There are some interesting things that we can do by reversing numbers:

1. Take an arbitrary 2-digit number, reverse the digits to make a second number and take the smaller from the greater. The difference is a multiple of 9.

   Example: 74 – 47 = 27 = 9 × 3.

   The elementary number theory behind this property should be accessible to some pupils as soon as they understand that a two digit number can be represented by $10a + b$ and its reverse by $10b + a$. Then, the difference is:

   $$\begin{aligned} 10a + b - (10b + a) &= 9a + 9b \\ &= 9(a + b). \end{aligned}$$

2. Take an arbitrary 3-digit number, reverse the digits and subtract the smaller from the greater. The result is a multiple of 11. For example: 691–196 = 495 = 11 × 45. Try representing a 3-digit number by $100a + 10b + c$ and see if you can prove the result.
3. Explore what happens when a 4-digit number is used.
4. Is there an analogue in time. Reverse 19:07 to give 07:19. What is the time difference?

Palindromes

In language, a palindrome is a word, sometimes a phrase, which reads the same forwards or backwards. In 1948, Leigh Mercer encapsulated the story of Ferdinand de Lesseps and his supervision of the Panama Canal project:

A MAN A PLAN A CANAL PANAMA.

As palindromes go, that takes some beating!

There are opportunities here to embellish lessons on transformations, as palindromes have a reflective property. Of course it is not the strict geometric reflection that also requires individual letters to be symmetrical, though words composed from the set of upper case letters {A, H, I, M, O, T, U, V, W, X, Y} should provide examples.

Numbers which read the same forwards and backwards are called palindromic numbers. So 16761 is palindromic but 387 is not. Here is a short investigation for the classroom: list and count the number of 1-digit, 2-digit and 3-digit palindromic numbers. For a larger task, try reaching palindromic numbers by reversing a number and adding the result to the original. For example, start with 69:

69	165	726	1353
+ 96	+ 561	+ 627	+ 3531
165	726	1353	4884

A palindromic number has been arrived at after four steps. Is a palindromic number reached regardless of the seed used? The vast majority do so and in a small number of iterations, making the activity ideal for the classroom. But beware, 196 may be an exception.

Acronyms

Acronyms are formed by taking the initial letters of several words to make a new word. Surely it would be good to be a member of:

S heffield
U niversity
M athematics
S ociety

Mathematical acronyms are in very short supply. We tend to have the lesser form, the abbreviation instead: LCM, HCF, gcd, BODMAS and so on.

Bacronyms

Bacronyms are reverse acronyms, taking the letters of one word as the initial letters of other words which define them, such as:

All	Any	Twelve,
Legitimate	Reduced	Eleven,
Generalizations	Circuit	... Next?
Effectively		
Bolstering		
Rational		
Arguments		

Try your hand at inventing some, or better still, see if your pupils can do so.

Mnemonics

Standard mnemonics in secondary mathematics include:

1. SOHCAHTOA
for the definitions of the trigonometric ratios, sine, cosine and tangent. It can be dressed up as:

Silly Orange Hair
Causes Absolute Hilarity
To Others Always

and probably in thousands of other ways.

2. FOIL
for the order of operations when expanding brackets: First, Outside, Inside, Last;

3. All Stations To Crewe
All Silver Tea Cups
A Silly Trig Chart

These are three examples of mnemonics for remembering the quadrants in which the trigonometric functions are positive.

Cryptarithm puzzles

A cryptarithm is a puzzle in which the digits of a sum (or other calculation) are hidden behind letters. Each different letter has a particular value, the object of the exercise being to reveal those values and establish the unique answer. Perhaps the most famous of them, and certainly the earliest, is this puzzle by Henry Dudeney,

SEND
+ MORE
MONEY

Possible solution

M in the total must be 1, since the total of the column, S+M, cannot reach 20. If M is replaced by 1, the total in this column must be at least 10, so that the 1 can be carried. S must be 8 or 9 and, in either case, the letter O must stand for zero (0 or 1 would be possibilities were it not for the fact that 1 has already been used for M).

With O representing zero, column EO cannot exceed 9, and with no 1 to carry over from this column to SM, S = 9.

Since E + O gives N, and O is zero, N must be 1 greater than E and the column NR must total over 10; so E + 1 = N.

From the NR column we can derive the relationship: N + R + (+1) = E + 10. The (+1) is included at this point because we don't know whether there is a carry from column DE. We do know that 1 is carried from column NR to EO. Combining the two relationships gives: R + (+1) = 9.

Since we have already assigned the value 9 to S, R ≠ 9. So we make R = 8, and that determines that 1 is carried over from column DE.

Column DE must total at least 12**,** since Y cannot be 1 or zero. What values can we give D and E to reach this total? The only digits that are sufficiently great are 7 and 6, and 7 and 5. However, one of these has to be E, and N is 1 greater than E. Hence E = 5, N = 6 and D = 7. Then Y turns out to be 2**,** and the puzzle is completely solved:

```
  9567
+1085
 10652
```

Incidentally, there are cryptarithms for astronomers:

```
    SATURN
    URANUS
   NEPTUNE
  +  PLUTO
   PLANETS
```

artists,

```
     MANET
   MATISSE
      MIRO
     MONET
  + RENOIR
   ARTISTS
```

and, of course, mathematicians;

```
   COMPLEX
+  LAPLACE
  CALCULUS
```

There are even examples of 'double-true', cryptarithms which are arithmetically correct, such as

```
    ONE
  THREE
+  FOUR
  EIGHT
```

Anagrams

When it comes to anagrams, maths teachers might enjoy noting that ELEVEN PLUS TWO is an anagram of TWELVE PLUS ONE, that as we always suspected, COMMITTEES ~ COST ME TIME and as A DECIMAL POINT once commented, I'M A DOT IN PLACE. There are two pairs of mathematical terms that are anagrams, TRIANGLE/INTEGRAL
ALGORITHM/LOGARITHM though worrying for the suriphobic mathematician is the fact that MATRICES are all RATS and MICE.

Let's finish with the lighter side of mathematics – some quotations and jokes.

Quotations

Pure mathematics is, in its way, the poetry of logical ideas. *Albert Einstein*
Mathematics - the unshaken Foundation of Sciences, and the plentiful Fountain of Advantage to human affairs. *Isaac Barrow*
A mathematician is a device for turning coffee into theorems. *Paul Erdös*
Let us grant that the pursuit of mathematics is a divine madness of the human spirit, a refuge from the goading urgency of contingent happenings. *Alfred North Whitehead*
Music is the pleasure the human mind experiences from counting without being aware that it is counting. *Gottfried Leibniz*
Mathematics is the supreme judge; from its decisions there is no appeal. *Tobias Dantzig*
Can you do Division? Divide a loaf by a knife – what's the answer to *that*? *Lewis Carroll*
[T]he different branches of Arithmetic - Ambition, Distraction, Uglification, and Derision. *Lewis Carroll*
As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality. *Albert Einstein*
If there is a God, he's a great mathematician. *Paul Dirac*
The laws of nature are but the mathematical thoughts of God. *Euclid*
Life is good for only two things, discovering mathematics and teaching mathematics. *Siméon-Denis Poisson*
A mathematician, like a painter or poet, is a maker of patterns. If his patterns are more permanent than theirs, it is because they are made with ideas. *G H Hardy*
Mathematics is like a game played according to certain simple rules with meaningless marks on paper. *David Hilbert*
The only way to learn mathematics is to do mathematics. *Paul Halmos*

Jokes

There are 10 types of people in this world: those who understand binary and those who don't.
A man has one hundred dollars and you leave him with two dollars. That's subtraction. *Mae West*
Arithmetic is being able to count up to twenty without taking off your shoes. *Mickey Mouse*

Old mathematicians never die; they just lose some of their functions.

Q: Why did the chicken cross the Möbius strip?
A: To get to the same side.

I hate negative numbers so much that I'll stop at nothing to avoid them.

Q: What do you get if you cross a mosquito with a mountaineer?
A: Nothing, you can't cross a vector and a scalar.

A physicist, a biologist and a mathematician are sitting in a café watching people entering and leaving the house opposite. They observe two people entering the house and, a little later, three people leaving the house. The physicist says, "The measurement wasn't accurate." The biologist says, "They must have reproduced." The mathematician says, "If one more person enters the house then it will be empty."