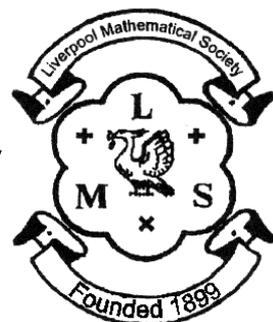


# MATHEMATICAL EDUCATION ON MERSEYSIDE

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# Challenge '15 For Year 8 or below

Illustrations by Peter H Ackerley

## Rules

- 1) Challenge '15 should be attempted at home during February half term.
- 2) Your entry must be your own work, though of course you may ask for help on how to get started or for the meanings of unfamiliar words.
- 3) Entries without any working out at all or written on this sheet **will not be marked**.
- 4) It is possible to win a prize even if you have not completed all of the questions, so hand in your entry even if it is not quite finished.
- 5) You must write **your name and school in neat writing on every page**.

Either you or your maths teacher needs to return your entry by 6<sup>th</sup> March to this address:

Challenge '15 Entries,  
Chris Marchant,  
Department of Mathematical Sciences,  
University of Liverpool,  
Peach Street,  
Liverpool.  
L69 7ZL.

A Prize Giving Evening will be held at the University of Liverpool on 6<sup>th</sup> May.  
We hope that you enjoy the questions.

### 1. Age Old Problem

When *Alice's Adventures in Wonderland* was first published in 1865, the combined ages of Alice Liddell, to whom Lewis Carroll first told the story, and Carroll himself were 46. Carroll was 20 years older than Alice Liddell. How old was each of them at the time?



### 2. REAL MADAM

While tumbling down the rabbit hole, Alice passes various shelves, on one of which is a jar of marmalade. In how many unique ways can the letters of MARMALADE be re-arranged to produce new 9-letter Wonderland words? Like much else in Wonderland, the words created do not necessarily need to appear to make sense!

### 3. Eat Me, Drink Me

On reaching the bottom of the rabbit hole, Alice finds a bottle labelled 'DRINK ME' and a cake with 'EAT ME' written on it in currants. She takes a drink from the bottle, which causes her to shrink. A bite from the cake then makes her grow a lot bigger!

Assume that Alice is 120cm tall to begin with, that the drink shrank her height by 60cm and that the cake increased her height by 100cm.

List all of the possible methods for restoring Alice to her original height, using the minimum possible number of drinks and the minimum possible number of bites of cake to achieve this.



#### 4. Rabbit, Rabbit, Rabbit

The White Rabbit gets married in January. At the start of February, he and his wife decide to have children; the first pair, one male and one female, is born exactly one month later. Another such pair follows at the same point in each subsequent month. When each new pair reaches two months old, they produce a similar new pair of their own, and repeat this monthly. How many rabbits will be in their family by Christmas Day?



#### 5. Pairs of Squares

The King of Hearts has a square photograph of himself and a square photograph of his wife (which is slightly smaller in size) hanging upon his wall. The Queen has the same two images, also as square photographs. Being a more narcissistic character, however, the image of herself that hangs upon her wall is much larger than her photograph of the King. Amazingly, the combined area of the King's two photographs is  $1865\text{cm}^2$  and this is also true of the Queen's two photographs! Given that all the photographs are a whole number of cm along each edge, what is the edge length of each particular photograph?



#### 6. The $\times$ Factor

Named after Lewis Carroll, a Carroll Diagram is used for grouping items depending upon whether or not they have specified properties.

Copy out the empty Carroll Diagram shown on the right, for which the entries are missing.

Grouping here is according to whether or not numbers are squares or cubes.

Complete your copy using the following clues:

The smaller numbers in the Carroll Diagram are all factors of the largest number.

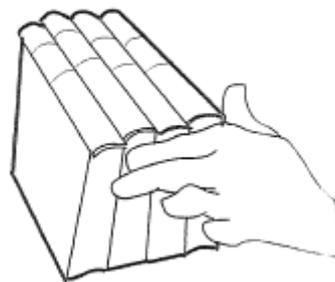
The entries in the boxes are all whole numbers which are greater than 1 and less than 100.

Each box in the Carroll Diagram must contain one or more numbers.

	Square number	Not a square number
Cube number		
Not a cube number		

## 7. Took a Book (or 4)

On a particular bookshelf at home, I have 15 different puzzle books and works of fiction. Five of these books were written by Lewis Carroll. While packing my suitcase for a holiday, I decide to take four books for poolside reading, and I select them at random from the shelf. What is the probability, as a proper fraction in its lowest terms, that exactly two of the books that I take away will be authored by Lewis Carroll?



The solutions will be posted on [www.maths.liv.ac.uk/~mem](http://www.maths.liv.ac.uk/~mem) shortly after the prize giving evening to be held at the University of Liverpool on 6<sup>th</sup> May

The competition is promoted by  
Mathematical Education on Merseyside (MEM)  
Registered Charity No 517028  
The Department of Mathematical Sciences,  
University of Liverpool,  
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