

MATHEMATICAL EDUCATION ON MERSEYSIDE

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Senior Challenge '13 For Year 10 or below

Illustrations by Peter H Ackerley

Rules

- 1) Challenge '13 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 9th March to this address:

Senior Challenge '13 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 24th April.
We hope that you enjoy the questions.

1. Fry's Delight

Miss Fry was given a box containing a variety of chocolates. Although she likes chocolates, she is not greedy, so she decided to share her chocolates and make them last. Her method of consumption was to eat one on the first day, and give away 10% of the remainder, to eat 2 on the second day and give 10% of the remainder away, eat three on the third day and give away 10% of the remainder, and continue in this way until no chocolates were left. How many chocolates were in the box and how many days did they last?



2. Bournville Dreams

A chocolate factory makes two different types of chocolate: dark and light. Each day, it receives 1200L of milk and 1200kg of cocoa. A batch of dark chocolate requires 20L milk and 50kg of cocoa. A batch of light chocolate requires 40L of milk and 30kg cocoa. The management insists that the workers produce at least 25 batches in total each day and that only full batches can be produced. The company makes a profit of £15 on a batch of dark chocolate and £10 on a batch of light chocolate. Work out how many batches of each type need to be produced to maximise profits.

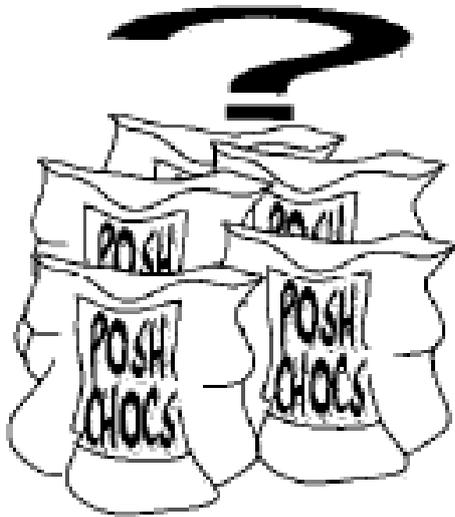
3. Christmas Celebrations

At Christmas, Ken likes to buy chocolates for family, friends and carol singers. He decides to spend £200 and has 100 people to buy for. He divides his spending between family-sized tins for £10, small selection packs for friends at £2, and fun-sized chocolate bars for carol singers at 20p each. Given that Ken has more friends than he anticipates carol singers, how many of each item should he buy?



4. Box Clever

The gift box for some Fairtrade hot chocolate powder is to be made from a single square sheet of card, with side length of 24cm, by cutting smaller squares (of integer side length) from the corners of the original square. It will then be folded up to make an open box (The lid is made separately). What is the maximum volume that can be obtained in this way? Show, using a graph, that this is the maximum volume.



5. Six After Eight

A small selection bag of posh Fairtrade chocolates contains 6 chocolates. These are a random selection from 8 different chocolates. A quality-control system is put in place to ensure that no selection contains more than 2 of the same chocolate or fewer than 4 different chocolates. How many different bags of chocolates are possible?

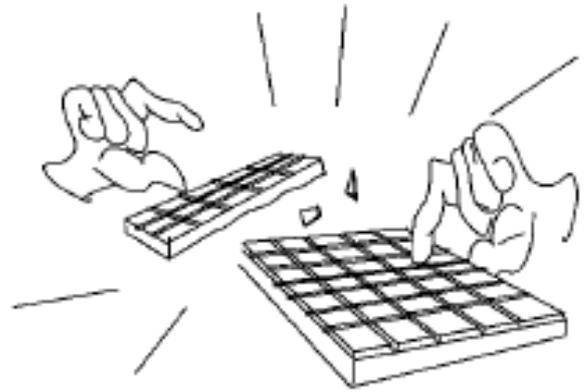
6. Seg-sational!

There are 20 segments in a chocolate orange. Modelling a chocolate orange as a sphere of diameter 5cm, with a cylindrical hollow of diameter 5mm running down the core, what is the volume of a segment? You may discount the small dome of chocolate at each of the 'poles' of the Chocolate Orange.



7. Breaking the Mould

Anna and Billy play a game with a rectangular chocolate bar that is 5 squares by 10 squares. Anna starts. They take turns breaking a piece of the bar (only one piece can be broken in one turn, always along the lines between the squares). The first player to break off a 1 by 1 square piece wins. Who wins the game?



8. A Year's Supply of Chocolate

Assume that all of the Cadbury's Dairy Milk bars bought in England were the standard length of 11.4cm. When laid end-to-end, they would form a line around the Earth along the line of latitude passing through Liverpool ($53\frac{1}{2}^{\circ}\text{N}$). Using the Earth's circumference at 40,075km at the equator, how many bars are sold in England each year?

The solutions will be posted on www.maths.liv.ac.uk/~mem shortly after the prize giving evening to be held at the University of Liverpool on 24th April

The competition is promoted by
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The Department of Mathematical Sciences,
University of Liverpool,
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