

MATHEMATICAL EDUCATION ON MERSEYSIDE

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Senior Challenge '25

Year 10 or below

Illustrations by Kira Wadeson

Rules

- 1) Senior Challenge '25 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 or certificate even if you have not completed all of the questions, so hand in your entry even if it is not quite finished.
- 5) Please make sure that you staple your pages together and you must write **your name and school neatly on every page**.

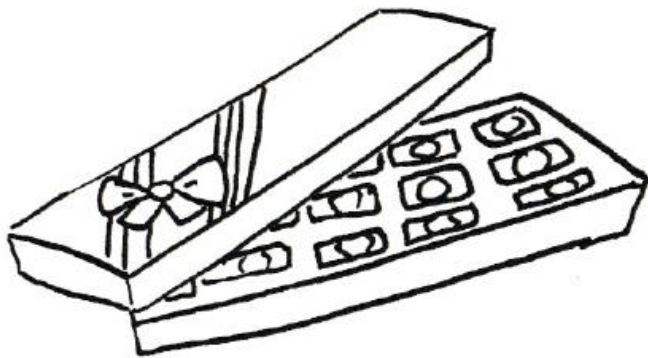
Either you or your maths teacher needs to return your entry by 7th March to this address:

Senior Challenge '25 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 Wednesday 7th May.
We hope that you enjoy the questions.

1. Strawberry laces

Abby, Brenda and Charlie are going to share a giant strawberry lace. Each friend takes $x\%$ of the lace, arriving one after another, and cutting the lace down to $(100-x)\%$ of the length they found. Given that the initial length was 500cm and the final remainder was 108cm, find the value of x . Hence give the length of strawberry lace that each friend takes.



3. Skittle Scenarios

Andrew likes skittles. He has a bag containing a mixture of yellow and green ones and a pocketful of green ones. Reaching into the bag, he extracts two at random. If they are the same colour, he eats them both and then puts one green skittle from his pocket into the bag. However, if they are of different colours, he eats the green one and puts the yellow one back into the bag. This delicious process is repeated until there is only one skittle left in the bag. How do the original contents of the bag determine the colour of this last skittle?

2. Selection Box

Ellie the Quality Assurance Manager has decreed new regulations for selection boxes, so they must contain no fewer than 9 and no more than 20 sweets, and must comprise the following:

- i) One third or more must be pear drops.
- ii) At least two sweets, but no more than one third, must be eclairs.
- iii) One fifth must be truffles.
- iv) One fifth or more must be mints.

Fractions must be rounded to the nearest whole number; e.g., a selection of 11 needs exactly 2 truffles.

How many of each of the 4 types of sweet should be contained in a selection of 9?

How many distinct ways can you fill a selection of 20?

4. Praline Packs Problem

Graham sells his pralines in three different-sized packets only: small packets containing 6 pralines, medium ones containing 9 and large ones containing 20. He refuses to split a packet.

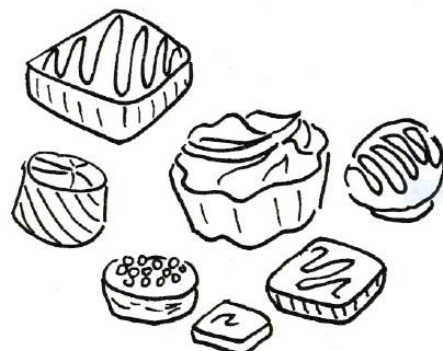
When Diane asked for 55 pralines, he gave her 2 large, 1 medium and 1 small packet.

For Eric's order of 101 pralines, Graham provided 4 large, 1 medium and 2 small packets.

When Frances asked for 19, he was unable to make that number. However, he rashly said that if she could tell him the largest number of pralines he could not supply, he would give her twice that number free of charge.

After a few minutes' thought, she worked out the number, so how many free sweets did she get?

Explain your answer.



5. Guess the Sweets in the Jar

Michael is planning a "Guess the Sweets in the Jar" competition for his school fête.

The space inside the jar containing the sweets is a cuboid measuring $100 \times 100 \times 200$ mm.

The sweets are a mixture of



Sweet	Dimensions (mm)
Fruit salads	$10 \times 20 \times 30$
Pink shrimps	$30 \times 20 \times 15$
Coconut mushrooms	$25 \times 25 \times 20$
Pineapple cubes	$20 \times 20 \times 20$
Foam bananas	$75 \times 20 \times 10$
White mice	$40 \times 20 \times 15$
Dew drops	$15 \times 15 \times 15$
Cola bottles	$10 \times 10 \times 50$
Jellybeans	$25 \times 10 \times 10$

At least 10% of the volume in the jar is occupied by each type of sweet. What is the maximum number of sweets he can fit into the jar?

6. Fancy Fondant

Sandra is making fondant in a cylindrical pan of diameter 24cm.

The length of the spoon she is using to stir is 25cm.

It accidentally falls into the fondant.

What is the minimum volume of fondant necessary to hide the spoon completely?

You may ignore the spoon's own volume.

7. Glorious Gobstoppers

Robert places gobstoppers with a diameter of 4cm into a cylinder of diameter 12cm. How many gobstoppers can he fit into a layer at the bottom of the cylinder?

He then adds in a second layer, such that each gobstopper in the second layer is touching 3 gobstoppers in the first layer. How far apart are the centres of these 3 gobstoppers?

Finally, he adds a single gobstopper as a third layer. How far above the base of the cylinder is the top of this final gobstopper?



8. Fab Fudge and Terrific Toffee

Prickleton's makes Premium Fudge and Toffee in batches, and never makes a part batch.

Ingredients per batch	Fudge	Toffee
Cream (litres)	400	300
Caster sugar (kg)	450	200
Butter (kg)	50	125

Every day, they are limited to:
9 m³ cream, 8 metric tonnes of sugar,
and 3 metric tonnes of butter.

For each batch of Fudge sold, Prickleton's makes £200 profit, and each batch of Toffee makes £250 profit. The other ingredients are essentially unlimited.

How many batches of each should they produce each day to maximise their profit, and what is the profit per day?

The competition is promoted by
Mathematical Education on Merseyside (MEM)
Registered Charity No 517028,
Department of Mathematical Sciences,
University of Liverpool,
Peach Street,
Liverpool,
L69 7ZL

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