

Senior Challenge '25

Year 10 or below

Illustrations by Kira Wadeson

Rules

- 1) The challenge should be attempted in your own time. Your entry must be **your own work**, though you may ask for help for the meanings of unfamiliar words. It is possible to win a prize or certificate even if you have not completed all the questions.
- 2) Present your worked solutions **separately on A4 size papers**. Lined papers are recommended, but blank or graph paper are accepted – as long as they are neatly presented. Do not write on this question sheet directly.
- 3) **Write your name and school on every page neatly.**
- 4) When you have completed, please scan your pages and save as a **single PDF file**. Make sure the scan is clear and legible.

Submission instructions

All submissions are done online. If you are planning to submit an entry, please ask your teacher¹ to fill in this form to register:

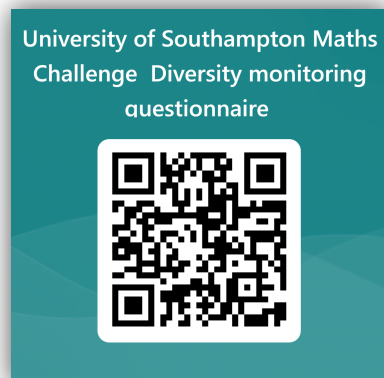
<https://forms.office.com/e/0wCqJwWcHj>

Only one registration per teacher is needed. Teachers will receive a link to upload as many entries as they need. All entries should be uploaded by **Friday 21 March 2025**. A Prize-Giving Evening will be held at the University of Southampton in June 2025.

We hope that you enjoy the questions!

Optional diversity monitoring questionnaire

Completing this questionnaire is **optional** and is **not a requirement** for participating in the Challenge. The questionnaire is meant to be completed by a parent or guardian of the participating student. This data is being collected for the purpose of assessing the diversity of participants in the Maths Challenge. The data will be stored and used in accordance with the University of Southampton's published Data Privacy Notice and Data Protection Policy.

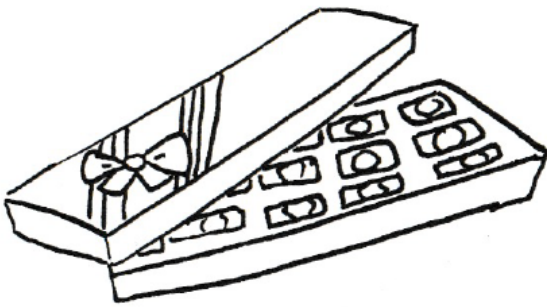


<https://forms.office.com/e/PgKjUA9sfc>

¹ If you are not affiliated with a school, you may also ask your parents to fill in the form and submit for you.

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 .



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.

- (a) How many of each of the 4 types of sweet should be contained in a selection of 9?
- (b) How many distinct ways can you fill a selection of 20?

3. Candy Scenarios

Andrew likes candy. 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 candy 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.

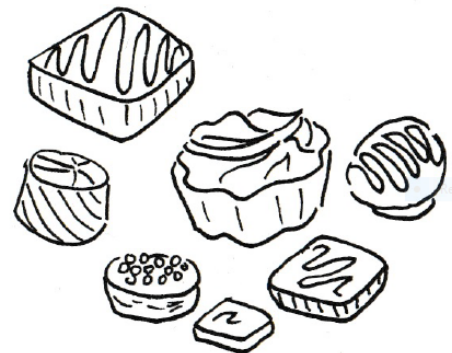
He continues this process until there is only one candy left in the bag.

How do the original contents of the bag determine the colour of this last candy?

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	$25 \times 10 \times 10$

Michael has managed to put the sweets in the jar in such a way that at least 10% of the volume in the jar is occupied by each type of sweet.

What is the maximum possible number of sweets he has 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.

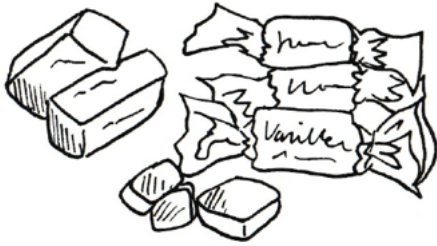
7. Glorious Gobstoppers

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 partial batches.

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 of 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 maximal profit per day?

9. Daniella's Experiment

Daniella has a scientific mind and enjoys conducting experiments, especially those involving computations. In her latest experiment, she uses a long, horizontally positioned ruler and three different types of sweet mini balls, made of: fig, chocolate, and coconut.

She begins by placing a total of 14 balls on the ruler, ensuring that exactly 5 of them are fig balls. She then simultaneously sets all the balls into motion at the same constant speed, either to the left or the right. The fig balls at the beginning move to the right, while the chocolate and coconut balls move to the left.

As the balls move, Daniella counts the number of collisions (or hits) that occur between the balls. It is assumed that after they hit, they continue their movement with the same constant speed but in opposite direction. Your task is to determine the maximum possible number of hits Daniella can count during this experiment.

To answer this question, you need to:

1. Specify how many chocolate balls and how many coconut balls Daniella should place on the ruler to achieve the maximum possible number of hits.
2. Describe the initial arrangement of the balls on the ruler (i.e., their order and positions relative to each other) that results in the maximum number of hits.
3. Explain why this arrangement produces the maximum number of hits.

— End of Challenge —