

Newcastle University

Challenge '20

Year 8 or below

Illustrations by Theo Chaddock

Rules

- 1) Challenge '20 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 2nd March to this address:

Maths Challenge Entries,
School of Mathematics, Statistics, & Physics
Newcastle University,
Newcastle upon Tyne
NE1 7RU.

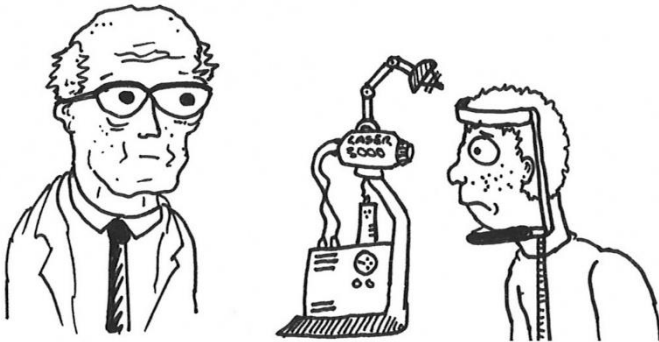
A Prize-Giving Evening will be held at Newcastle University on 29th April.
We hope that you enjoy the questions.

1. Barry's Blocks

Barry has 4 wooden identically sized and shaped blocks. 2 are blue, 1 is red and 1 is green.

How many distinct ways can Barry arrange the 4 blocks in a row?

Barry's friend Billie is colour-blind, and cannot distinguish between red and green. How many of Barry's distinct arrangements would Billie see as different?



2. Peter's Patients

Peter the optician sees 16 patients one Tuesday. 4 are neither short nor long sighted. The total number of short sighted patients is two more than the total number of long sighted patients. How many patients can be short sighted, how many can be long sighted and how many could require varifocal lenses?

3. Light Work

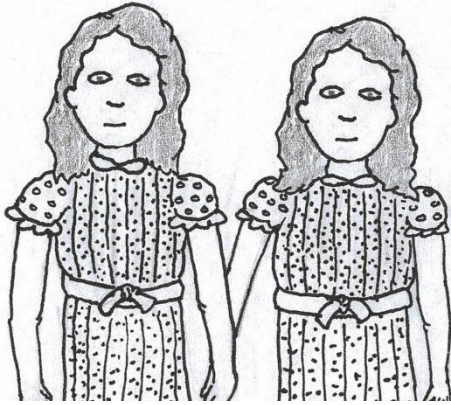
Oscar has 6 tubular neon lights in order to spell out the word VISION to promote his lighting business. It costs £2 to add a corner to a tube, £3 to wire the ends of two tubes together (or the two ends of one tube). It is free to add smooth curves or to stretch the tubes.

How much does it cost Oscar to spell the word VISION? Which capital letters of the alphabet is it possible to make with a single tube using the Arial font? Justify your answer.



4. Window Cleaning

A skyscraper has 100 floors, numbered 0 (ground floor) to 99, each with one window. A team of 10 inefficient window cleaners are hired to clean the windows. They work from bottom to top and, when each cleaner has cleaned their highest floor, they leave. The 1st cleaner cleans every 10th window (so her first window is on the 9th floor), the 2nd cleans every 9th window, the 3rd cleans every 8th window and so on until the 9th cleans every 2nd window. The final cleaner has an attack of vertigo and can't work. Which floors will still have dirty windows?



5. Spot the Difference

Twins can be identical boys, identical girls, non-identical boys, non-identical girls or one boy and one girl.

What are the possible combinations with triplets?

What are the possible combinations with quadruplets?

6. Schedule Shenanigans

Nick the TV scheduler is writing the Christmas Eve schedule from 6pm to midnight. These are the shows to be broadcast:

- 3 fifteen-minute News bulletins; there must be at least $2\frac{1}{2}$ hours between bulletins
- 'Night of the Zombie Reindeer', a $2\frac{1}{2}$ -hour film which must be shown after the 9pm watershed
- a 30-minute astronomy programme – 'Stars on TV'
- a 60-minute Christmas special of 'The Liver Robins'
- the Christmas episode of Eastdale Street (30 mins)
- a 45-minute sci-fi programme (Snowmen in Space).

His wife, Mary, an avid Eastdale Street fan, has asked him to ensure that it doesn't start before 8pm so she can be home in time to watch it live.

Meanwhile, their young daughter Holly has asked him to put The Liver Robins on early enough for her to watch it before her mum puts her to bed when she gets in.

Assuming no advert breaks, how could he fit it all in?

Ryan Pippin, the presenter of 'Stars on TV', gets embroiled in an academic scandal and the programme needs to be pulled from the schedule. It is to be replaced with 3 ten-minute programmes called 'Santa Watch'. These need to be spread as evenly as possible through the night, whilst keeping the news bulletins at least $2\frac{1}{2}$ hours apart.

How can the schedule be rearranged?

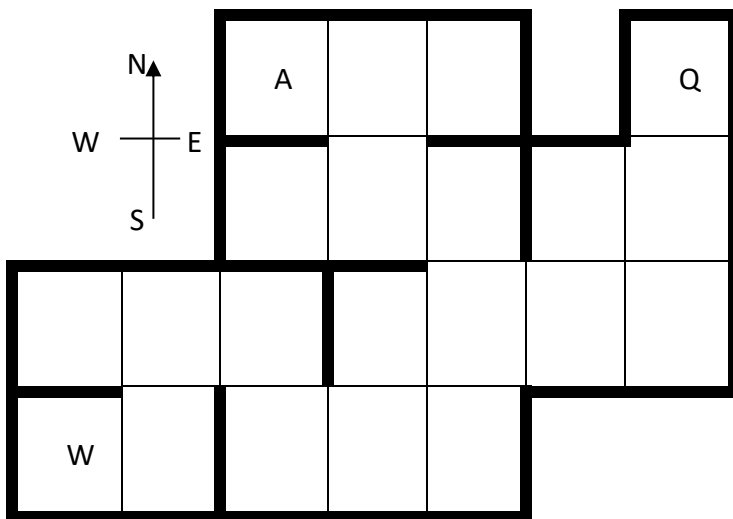


7. Second Sight

Zelda the psychic has minimal psychic powers. When she tries to 'see' which card Hilda is holding, she gets the colour correct 100% of the time. She can also tell if it is a picture card (King, Queen, Jack) or not. Being a romantic, when a card is a Heart, her chances of correctly identifying the face value are doubled; however, she hates gardening, so, when a card is a spade, her chances of finding the right face value are halved. What is the probability that she guesses correctly if Hilda is holding the Ten of Diamonds, the Jack of Clubs, the Queen of Hearts or the Ace of Spades?



a



8. Go With the Flo

Florence Nightingale, born in 1820, is moving around a hospital, and is trying to avoid the administrator who is a terrible bore. It is a dark and stormy night, and she won't go outside. On the map on the left, each square represents a room. Thin lines are walls with a door in them, thick lines are walls without a door in them.

Each time Florence moves into an adjacent room, the administrator also moves into an adjacent room; however, he is superstitious and so he does not re-enter a room he has just left, although he can return to a room later. She starts on the ward (W), whilst he starts in the admin office (A).

How might she be able to reach her quarters (Q) without being caught by him?

The Challenge is organised by:-

School of Mathematics, Statistics & Physics
Newcastle University
Newcastle upon Tyne
NE1 7RU

For more information or if you have any questions, visit:-

<http://www.ncl.ac.uk/maths/outreach/teachers/challenge/>

Please note that entries will not be returned, though solutions will be available shortly before 29th April.

The School of Mathematics, Statistics and Physics would like to acknowledge the University of Liverpool and Mathematical Education on Merseyside for developing the Challenge questions