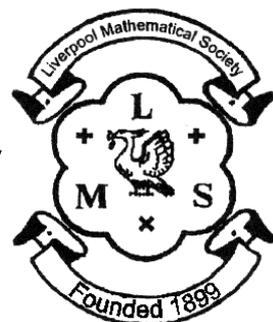# MATHEMATICAL EDUCATION ON MERSEYSIDE

Sponsored by

Challenge '16
For Year 8 or below

Illustrations by Theo Chaddock and Peter H Ackerley

Rules
1) Challenge '16 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 4th March to this address:
Challenge '16 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 11th May.
We hope that you enjoy the questions.

1. Ken's Grandmothers

Ken, who lives in Liverpool, has two grandmothers; Gladys lives in Southport and Audrey in Chester. He goes to see them by train from Liverpool Central Station, at no particular fixed time. To avoid deciding whom to visit, he always takes the first possible train to either destination when he arrives at the station.
There is one train every fifteen minutes to each destination, so he thinks this is fair.
However, Ken finds that over time he sees Gladys four times as often as Audrey.
Explain how this is so.
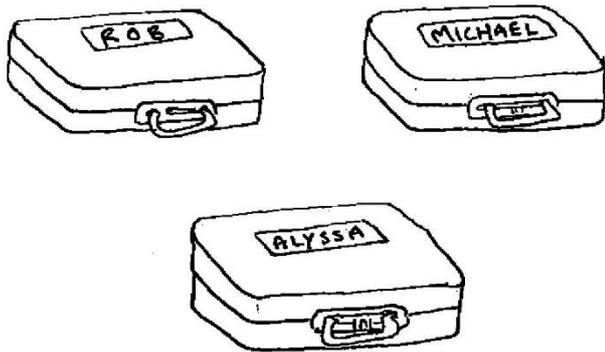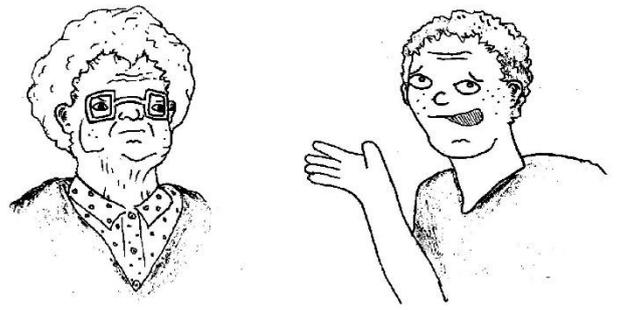
2. Suitcase Roulette

Rob, Michael and Alyssa arrive at Marseille Provence Airport.
Their three suitcases are identical, and the name labels were mixed up at check-in so that no label is on the right luggage!
Alyssa remarks that she brought no socks; both the others confirm aloud that they did pack socks. Rob picks up a suitcase and glances at its name label. He then begins to open it and a pair of socks falls out.
'Ah!' Rob exclaims, without looking inside.
'This suitcase is obviously mine.'
Explain how Rob could know.
Whose name is on his suitcase?
Which labels are on Michael's suitcase and on Alyssa's suitcase?

3. To B or Not To B?

A town planner decides to introduce a new one-way system, as shown on the map. The arrows indicate the direction of traffic flow on each street.
Show that you can get from A to every street in the town.
Can you leave from every street to get to B?
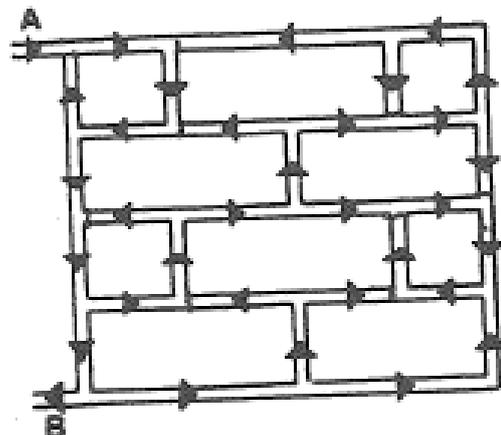
4. French Wanderings

Rob, Michael and Alyssa are going to France for the EURO 2016 tournament.

Their flights are into and out of Marseille.

They plan to attend one match there and also visit every other host city in the south of the country; they do not wish to pass through cities more than once during their tour.

Help them to find the shortest route in km around the venues, from the start to the end of their trip.

Indicate your strategy and state the total length of the shortest route.

(Striking French lorry drivers are preventing interchange between the Nice – Toulouse road and the two roads which it crosses!)

Lyon

555

St-Etienne   60

470

Bordeaux   535

320

245

535   335

560   Nice

Toulouse

400   205

Marseille
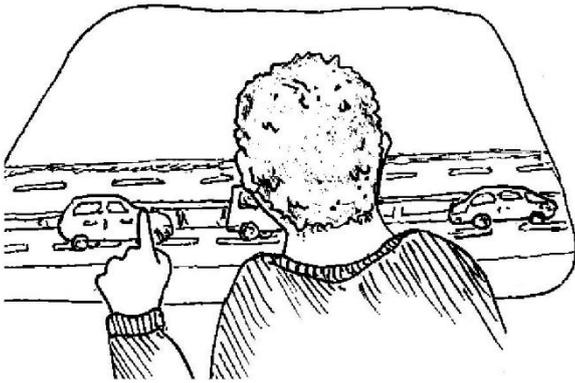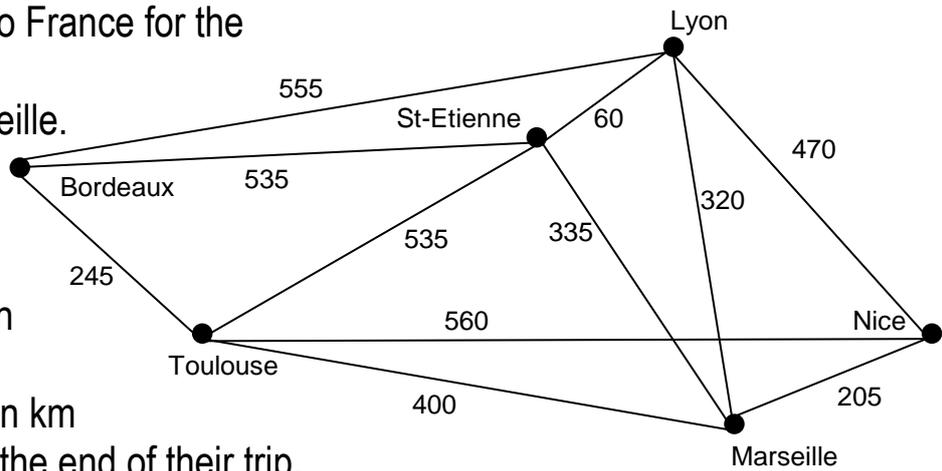
5. Tunnel Vision

The Queensway Tunnel under the River Mersey has 4 traffic lanes: a fast and a slow lane in each direction. Vehicles in the fast lane travel at 55kph and are 25 metres apart. Vehicles in the slow lane travel at 35kph and are 20m apart.

When being driven through the tunnel, Alex and Matthew play a game of counting the vehicles that they pass heading the other way. Alex counts the vehicles in the fast lane, whilst Matthew counts the vehicles in the slow lane. Who counts more vehicles if the boys' car is in the fast lane? Who counts more if it is in the slow lane?

6. Arrowhead Island

Arrowhead Island has just five small towns. Cold Harbour is at the northern tip of the island and Eastward Ho is on the Eastern side. Aberbay, Burnmouth and Deepcove are also all on the coast. There are just two roads: one goes around the coast visiting all five towns; the other goes across the island from one town to another. The mileage table shows the shortest distance by road between the five towns. Make a road map of the island.

	A	B	C	D
B	4			
C	7	11		
D	2	3	9	
E	6	7	10	4

7. Trains in the Tunnel

There is a railway tunnel under the River Mersey between Hamilton Square and James Street stations. Each train takes exactly 3 minutes to travel between these stations in either direction.

Trains leave Hamilton Square for James Street at these minutes past the hour:
01, 06, 11, 14, 16, 21, 26, 31, 36, 41, 44, 46, 51, 56.

Trains leave James Street for Hamilton Square at these minutes past the hour:
02, 07, 12, 17, 22, 24, 27, 32, 37, 42, 47, 52, 54, 57.

For which minutes in a given hour will the tunnel be empty?

For which minutes in a given hour will there be trains in the tunnel running in both directions simultaneously?

8. Ella and Siân

Ella and Siân have cycled 16km from home, when the back wheel of Ella's bicycle falls off. Ella is fortunately uninjured (a rarity for Ella) and so they decide to set off for home, leaving her bicycle secured to a tree.

They agree that Ella will start walking and Siân will start on her bicycle. After some time, Siân will leave the bicycle locked to a lamp post and continue on foot so that, when Ella reaches the bicycle, she can unlock it (they both have a key for the lock) and use it to cycle the rest of the journey.

Ella walks at 4km per hour and cycles at 10km per hour; Siân walks at 5km per hour and cycles at 12 km per hour.

For what length of time should Siân ride the bicycle, so that they both arrive home together, and how long will the whole journey take them?