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United Kingdom
Mathematics Trust

Junior Mathematical Challenge

Tuesday 30 April 2019

Organised by the United Kingdom Mathematics Trust

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England & Wales: *Year* 8 *or below*
Scotland: *S*2 *or below*
Northern Ireland: *Year* 9 *or below*

Instructions

1. Do not open the paper until the invigilator tells you to do so.
2. Time allowed: **60 minutes**.
   No answers, or personal details, may be entered after the allowed time is over.
3. The use of blank or lined paper for rough working is allowed; **squared paper**, **calculators and measuring instruments are forbidden**.
4. **Use a B or an HB non-propelling pencil.** Mark at most one of the options A, B, C, D, E on the Answer Sheet for each question. Do not mark more than one option.
5. **Do not expect to finish the whole paper in the time allowed.** The questions in this paper have been arranged in approximate order of difficulty with the harder questions towards the end. You are not expected to complete all the questions during the time. You should bear this in mind when deciding which questions to tackle.
6. **Scoring rules:**
   5 marks are awarded for each correct answer to Questions 1-15;
   6 marks are awarded for each correct answer to Questions 16-25;
   Each incorrect answer to Questions 16-20 loses 1 mark;
   Each incorrect answer to Questions 21-25 loses 2 marks.
7. Your Answer Sheet will be read by a machine. **Do not write or doodle on the sheet except to mark your chosen options.** The machine will read all black pencil markings even if they are in the wrong places. If you mark the sheet in the wrong place, or leave bits of eraser stuck to the page, the machine will interpret the mark in its own way.
8. **The questions on this paper are designed to challenge you to think, not to guess.** You will gain more marks, and more satisfaction, by doing one question carefully than by guessing lots of answers. This paper is about solving interesting problems, not about lucky guessing.

Enquiries about the Junior Mathematical Challenge should be sent to:

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☎ 0113 343 2339 enquiry@ukmt.org.uk www.ukmt.org.uk

1. How many minutes is it from 23:35 today to 01:15 tomorrow?

A 100 B 110 C 120 D 130 E 140

2. Which of these is equal to $(0.1 + 0.2 + 0.3 - 0.4) \div 0.5$?

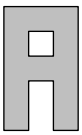
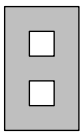
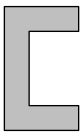
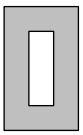
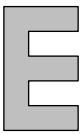
A 0.01 B 0.02 C 0.04 D 0.1 E 0.4

3. Sam has eaten three-quarters of the grapes.

What is the ratio of the number of grapes that remain to the number Sam has eaten?

A 1 : 3 B 1 : 4 C 1 : 5 D 1 : 6 E 1 : 7

4. Which of the following five shapes can be cut into four pieces by a single straight cut?

A  B  C  D  E 

5. On Aoife's 16th birthday, Buster was three times her age. On Aoife's 21st birthday, how old was Buster?

A 32 B 48 C 53 D 63 E 64

6. Which of these is closest to 7?

A 7.09 B 6.918 C 7.17 D 6.7 E 7.085

7. The shortest street in the UK, *Ebenezer Place* in Wick, is 2.06 m long. The *Trans-Canada Highway*, one of the world's longest roads, is approximately 7821 km in length.

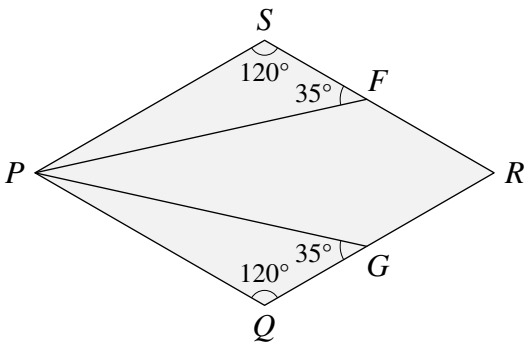
Approximately, how many times longer than the street is the highway?

A 4 000 000 B 400 000 C 40 000 D 4000 E 400

8. The diagram shows a kite $PGRF$ inside rhombus $PQRS$.
Angle $PGQ = 35°$, angle $PFS = 35°$,
angle $PQG = 120°$ and angle $PSF = 120°$.

What is the size of angle FPG?

A 10° B 12° C 15° D 18° E 20°



9. What is 50% of 18.3 plus 18.3% of 50?

A 9.15 B 18.3 C 27.15 D 59.15 E 68.3

10. What is the last digit of the smallest positive integer whose digits add to 2019?

A 1 B 4 C 6 D 8 E 9

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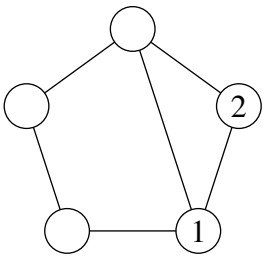
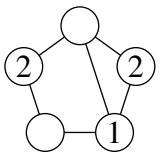
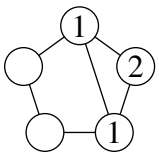
11. Two players X and Y take alternate turns in a game, starting with the diagram alongside.

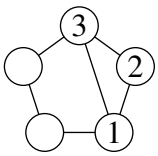


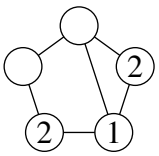
At each turn, one player writes one of 1, 2 or 3 in an empty circle, so that no two circles connected by an edge contain the same number. A player loses when they cannot go. In each of the five diagrams below it is Y's turn.

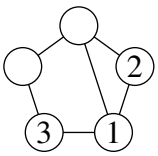
In which of the diagrams can Y's move ensure that X loses the game?

A 

B 

C 

D 

E 

12. Jamal writes down a sequence of six integers. The rule he uses is, "after the first three terms, each term is the sum of the three previous terms." His sequence is —, —, —, 8, 13, 25.

What is his first term?

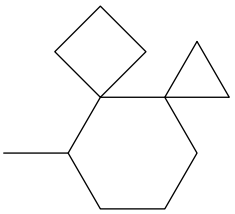
A 0 B 1 C 2 D 3 E 4

13. In how many different ways can you spell out JMC, starting at the centre, and moving to the next letter in a neighbouring square – horizontally, vertically, or diagonally – each time?

C	C	C	C	C
C	M	M	M	C
C	M	J	M	C
C	M	M	M	C
C	C	C	C	C

A 8 B 16 C 24 D 25 E 32

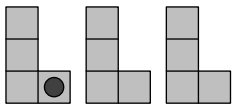
14. Each edge in the diagram has length 1 cm.

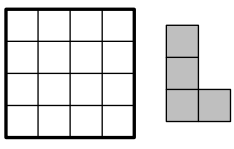


What is the length of the longest path that can be followed along the edges, starting at a vertex and without revisiting any vertex?

A 7 cm B 8 cm C 9 cm D 10 cm E 11 cm

15. All four L-shapes shown in the diagram are to be placed in the 4 by 4 grid so that all sixteen cells are covered and there is no overlap. Each piece can be rotated or reflected before being placed and the black dot is visible from both sides.





How many of the 16 cells of the grid could contain the black dot?

A 4 B 7 C 8 D 12 E 16

16. Tamsin writes down three two-digit integers. One is square, one is prime and one is triangular. She uses the digits 3, 4, 5, 6, 7 and 8 exactly once each.

Which prime does she write?

A 37 B 43 C 53 D 73 E 83

17. A rectangle is three times as long as it is high. The area of a square is twelve times the area of the rectangle. What is the ratio of the perimeter of the square to the perimeter of the rectangle?

A 12 : 1 B 6 : 1 C 4 : 1 D 3 : 1 E 2 : 1

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18. What fraction of the integers from 1 to 8000 inclusive are cubes?

A $\frac{1}{1000}$ B $\frac{1}{800}$ C $\frac{1}{400}$ D $\frac{1}{200}$ E $\frac{1}{100}$

19. Each row, each column and each of the bold 2 by 3 rectangles in the grid has to contain each of the numbers 1, 2, 3, 4, 5 and 6 (one number in each cell).

What number should go in the cell marked x?

A 1 B 2 C 3 D 4 E 6

				x	5
				6	
		1	2		
		3	4		
		4		3	
2					1

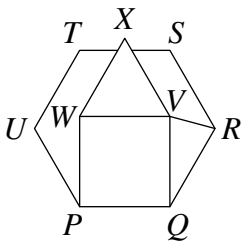
20. Emily writes down the largest two-digit prime such that each of its digits is prime.
Krish writes down the smallest two-digit prime such that each of its digits is prime.
Kirsten subtracts Krish's number from Emily's number.
What answer does Kirsten obtain?

A 14 B 20 C 36 D 45 E 50

21. The diagram shows a regular hexagon $PQRSTU$, a square $PQVW$ and an equilateral triangle VXW.

What is the size of angle XVR?

A 120° B 125° C 130° D 135° E 140°



22. In the multiplication shown alongside, T, R, A and P are all different digits.

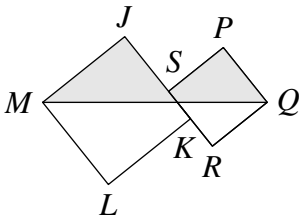
What is the value of R?

A 0 B 1 C 5 D 8 E 9

$$\begin{array}{cccc} T & R & A & P \\ \times & & & 9 \\ \hline P & A & R & T \end{array}$$

23. The diagram shows two squares $JKLM$ and $PQRS$.
The length of JK is 6 cm and that of PQ is 4 cm.
The vertex K is the midpoint of side RS.
What is the area of the shaded region?

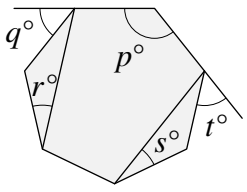
A 22 cm^2 B 24 cm^2 C 26 cm^2 D 28 cm^2
E 30 cm^2



24. The diagram shows a regular heptagon.

Which of these expressions is equal to $p + q + r + s + t$?

A $180 + q$ B $180 + 2q$ C $360 - q$ D 360
E $360 + q$



25. The diagram shows the first fifteen positive integers arranged in a 'triangle'.
These numbers are to be rearranged so that the five integers along each 'edge' of the triangle have the same sum, unlike the example shown.
When this is done, what is the greatest possible such sum?

A 38 B 42 C 48 D 52 E 54

5
10 1
7 13 14
3 8 2 12
15 4 9 6 11

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