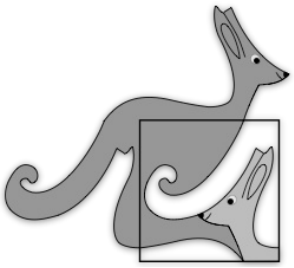
United Kingdom
Mathematics Trust



Pink Kangaroo

Thursday 16 March 2023

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a member of the Association Kangourou sans Frontières

England & Wales: Year 11 or below
Scotland: S4 or below
Northern Ireland: Year 12 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;
   In this paper you will not lose marks for getting answers wrong.
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 Pink Kangaroo should be sent to:

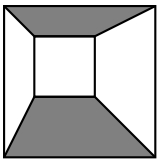
challenges@ukmt.org.uk

www.ukmt.org.uk

1. Kangaroo Day this year falls on Thursday 16th March 2023. What day will it be in 2023 days' after this date?

A Sunday B Monday C Tuesday D Wednesday E Thursday

2. A large square of side-length 10 cm contains a smaller square of side-length 4 cm, as shown in the diagram. The corresponding sides of the two squares are parallel. What percentage of the area of the large square is shaded?

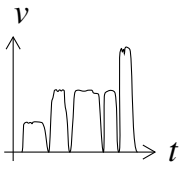


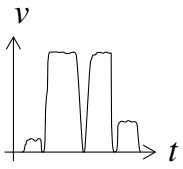
A 25% B 30% C 40% D 42% E 45%

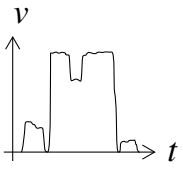
3. A wooden fence consists of a series of vertical planks, each joined to the next vertical plank by four horizontal planks. The first and last planks in the fence are vertical. Which of the following could be the total number of planks in the fence?

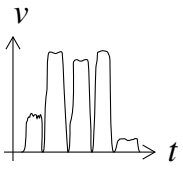
A 96 B 97 C 98 D 99 E 100

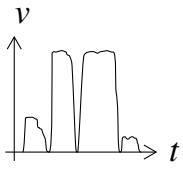
4. Mary had to run to catch the train, got off two stops later and then walked to school. Which of the following speed-time graphs would best represent her journey?

A 

B 

C 

D 

E 

5. Alec has won 49% of the 200 games of chess he has played. He would like to have won exactly 50% of his games. What is the smallest number of extra games he needs to play?

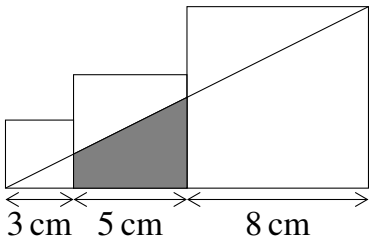
A 0 B 1 C 2 D 3 E 4

6. Lucy is trying to save water. She has reduced the time she spends in her shower by one quarter. Also, she has lowered the water pressure to reduce the rate the water comes out of the shower head by a quarter. By what fraction has Lucy reduced the total amount of water she uses when she showers?

A $\frac{3}{8}$ B $\frac{1}{16}$ C $\frac{5}{12}$ D $\frac{7}{16}$ E $\frac{9}{16}$

7. The diagram shows three squares of side-length 3 cm, 5 cm and 8 cm. What is the area, in cm^2, of the shaded trapezium?

A 13 B $\frac{55}{4}$ C $\frac{61}{4}$ D $\frac{65}{4}$ E $\frac{69}{4}$



8. A wire of length 95 m is cut into three pieces such that the length of each piece is 50 % greater than the previous piece. What is the length of the largest piece?

A 36 m B 42 m C 45 m D 46 m E 48 m

9. The ages of a family of five sum to 80. The two youngest are 6 and 8.
What was the sum of the ages of the family seven years ago?

A 35 B 36 C 45 D 46 E 66

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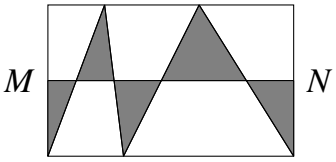
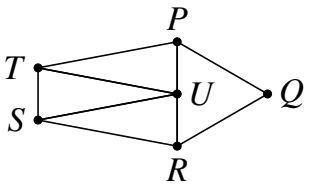
10. Points M and N are the midpoints of two sides of the rectangle, shown in the diagram. What fraction of the rectangle's area is shaded?



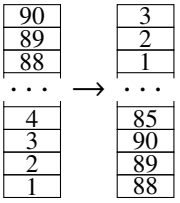
A $\frac{1}{6}$ B $\frac{1}{5}$ C $\frac{1}{4}$ D $\frac{1}{3}$ E $\frac{1}{2}$

11. The Pentagon $PQRST$ is divided into four triangles with equal perimeters. The triangle PQR is equilateral. PTU, SUT and RSU are congruent isosceles triangles. What is the ratio of the perimeter of the pentagon $PQRST$ to the perimeter of the triangle PQR?



A 2 : 1 B 3 : 2 C 4 : 3 D 5 : 3 E 5 : 2

12. On the table there is a tower made of blocks numbered from 1 to 90, as shown on the left of the diagram. Yett takes blocks from the top of the tower, three at a time, to build a new tower, as shown on the right of the diagram. How many blocks will be between blocks 39 and 40 when he has finished building the new tower?

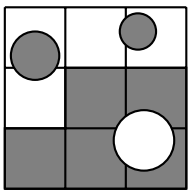


A 0 B 1 C 2 D 3 E 4

13. We will call a two-digit number **power-less** if neither of its digits can be written as an integer to a power greater than 1. For example, 53 is power-less, but 54 is *not* power-less since $4 = 2^2$. Which of the following is a common divisor of the smallest and the largest power-less numbers?

A 3 B 5 C 7 D 11 E 13

14. A square of side-length 30 cm is divided into nine smaller identical squares. The large square contains three circles with radii 5 cm (bottom right), 4 cm (top left) and 3 cm (top right), as shown. What is the total area of the shaded part?

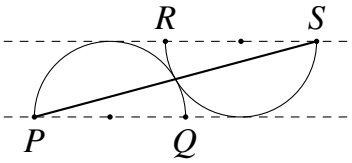


A $400\,\text{cm}^2$ B $500\,\text{cm}^2$ C $(400 + 50\pi)\text{cm}^2$
D $(500 - 25\pi)\text{cm}^2$ E $(500 + 25\pi)\text{cm}^2$

15. Jenny calculates the average of five different prime numbers. Her answer is an integer. What is the smallest possible integer she could have obtained?

A 2 B 5 C 6 D 12 E 30

16. The figure shows two touching semicircles of radius 1, with parallel diameters PQ and RS. What is the square of the distance PS?



A 16 B $8 + 4\sqrt{3}$ C 12 D 9
E $5 + 2\sqrt{3}$

17. Ireena is extending a sequence of numbers with the following rule. The next term in the sequence is the smallest non-negative integer that is different from each of the four preceding terms. She then repeats this process over and over again. For instance, if Ireena was to start with the sequence 7, 3, 1, 8 then the fifth and sixth terms of the sequence would be 0 and 2 respectively.

Ireena starts with the sequence

2, 0, 2, 3.

What is the 2023rd number in this sequence?

A 0 B 1 C 2 D 3 E 4

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18. A group of students took a test which consisted of 3 questions. We know that 90 % answered the first question correctly, 80 % answered the second question correctly and 70 % answered the third question correctly. What is the smallest possible percentage of students who answered all three questions correctly?

A 30 % B 35 % C 40 % D 50 % E 70 %

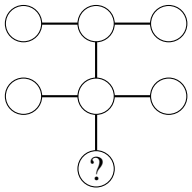
19. A rectangle with vertices $(0, 0)$, $(100, 0)$, $(100, 50)$ and $(0, 50)$ has a circle with centre $(75, 30)$ and radius 10 cut out of it. What is the slope of the line through the point $(75, 30)$ which divides the remaining area of the rectangle into two shapes of equal area?

A $\frac{1}{5}$ B $\frac{1}{3}$ C $\frac{1}{2}$ D $\frac{2}{5}$ E $\frac{2}{3}$

20. Eva chooses a three-digit positive number and from it she subtracts the sum of its three digits. She finds that the answer is a three-digit number in which all three digits are the same. How many different starting numbers could Eva have chosen?

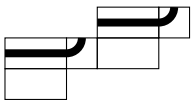
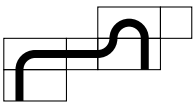
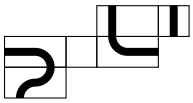
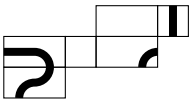
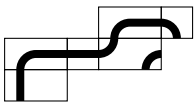
A 2 B 5 C 10 D 20 E 30

21. Seven different single-digit numbers are written in the circles of the diagram shown with one number in each circle. The product of the three numbers in each of the three lines of three numbers is the same. Which number is written in the circle containing the question mark?



A 2 B 3 C 4 D 6 E 8

22. Lancelot has drawn a closed path on a cuboid and unfolded it into a net. Which of the nets shown could *not* be the net of Lancelot's cuboid?

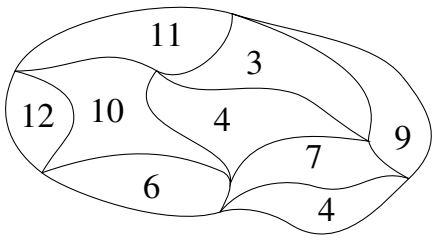
A  B  C  D  E 

23. In how many different ways can the word **BANANA** be read from the following table by moving from one cell to another cell with which it shares an edge? Cells may be visited more than once.

B	A	N
A	N	A
N	A	N

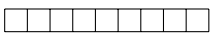
A 14 B 28 C 56 D 84 E 112

24. The diagram shows a map of a park. The park is divided into regions. The number inside each region gives its perimeter, in km. What is the outer perimeter of the park?



A 22 km B 26 km C 28 km D 32 km E 34 km

25. Vumos wants to write the integers 1 to 9 in the nine boxes shown so that the sum of the integers in any three adjacent boxes is a multiple of 3. In how many ways can he do this?



A $6 \times 6 \times 6 \times 6$ B $6 \times 6 \times 6$
C $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$ D $6 \times 5 \times 4 \times 3 \times 2 \times 1$
E $9 \times 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$

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