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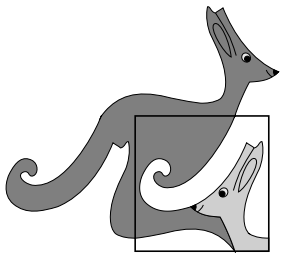

Grey Kangaroo

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Solutions

These are polished solutions and do not illustrate the process of failed ideas and rough work by which candidates may arrive at their own solutions.

It is not intended that these solutions should be thought of as the 'best' possible solutions and the ideas of readers may be equally meritorious.

Enquiries about the Grey Kangaroo should be sent to:

challenges@ukmt.org.uk

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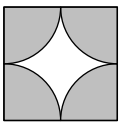
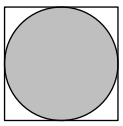
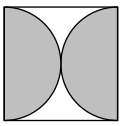
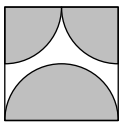
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
E	E	D	C	C	A	B	E	E	C	D	B	A	D	A	C	C	B	B	D	D	B	E	A	E

1. The diagrams show four squares of the same size and a circle and parts of a circle, all of which have the same radius. In which diagram does the shaded part have the largest area?

A  B  C  D 

E All shaded parts have the same area

SOLUTION **E**

Since all the circles and parts of circles have the same radius, the four quarter-circles in option A have the same total area as the circle in option B. Similarly, the two half-circles in option C and the half-circle and two quarter-circles in option D also have the same area as the circle in option B. Therefore the shaded parts in all four diagrams have the same area.

2. There are three different routes from Exe to Wye. There are five different routes from Wye to Zed. Ahmed travels from Exe to Zed via Wye. He wants to travel back from Zed to Exe via Wye using a route that is not completely the same as the route he used from Exe to Zed.
How many different routes could he use for his return trip?

A 5 B 6 C 10 D 12 E 14

SOLUTION **E**

The total number of routes from Exe to Zed via Wye is $3 \times 5 = 15$. Since Ahmed wants to travel back using a different route to the one he used first time, the number of possible routes for his return journey is $15 - 1 = 14$.

3. Jo wants to write the digits 2, 0, 2 and 6 in the boxes shown with one digit in each box and to calculate the result. What is the smallest positive result she could obtain?

$$\frac{\square + \square}{\square - \square}$$

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

SOLUTION **D**

To obtain a positive result, the denominator of the fraction, where there is a subtraction, needs to be positive. Therefore the possible denominators are $6 - 0$, $6 - 2$ and $2 - 0$, with corresponding numerators $2 + 2$, $2 + 0$ and $6 + 2$. The values of the resulting fractions in these cases are $\frac{4}{6} = \frac{2}{3}$, $\frac{2}{4} = \frac{1}{2}$ and $\frac{8}{2} = 4$ respectively. Hence the smallest possible positive answer is $\frac{1}{2}$.

4. Which of the following numbers is *not* the sum of two or more consecutive positive integers?

A 6 B 7 C 8 D 9 E 10

SOLUTION **C**

Any odd number can be written as the sum of two consecutive positive integers. In the case of the odd numbers given in the options, we have $7 = 3 + 4$ and $9 = 4 + 5$. Also, note that $6 = 1 + 2 + 3$ and $10 = 1 + 2 + 3 + 4$. Also, since $2 + 3 + 4 = 9 > 8$, 8 cannot be written as the sum of two or more consecutive positive integers.

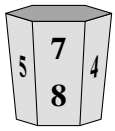
5. Eva is looking at four seats in a row, numbered 1 to 4 from left to right, which are occupied by Andi, Budi, Citra and Dira, but not in that order. The following statements are true: Andi is not in seat 1; Budi is seated directly to the right of Andi; Dira is not at either end.
In what order, from left to right, do they sit?

A Budi, Dira, Andi, Citra
B Citra, Andi, Dira, Budi
C Citra, Dira, Andi, Budi
D Citra, Dira, Budi, Andi
E Dira, Citra, Budi, Andi

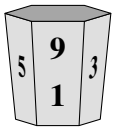
SOLUTION **C**

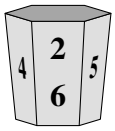
The question tells us that Andi is not in seat 1 and, since Budi is seated to the right of Andi as Eva looks, Andi is not in seat 4 either. We are also told that Dira is not at either end and hence we know that seats 2 and 3 are occupied by Andi and Dira, in some order. However, were Andi to be sitting in seat 2, Budi would have to be in seat 3 to be sitting directly to the right of Andi, which would contradict Dira being in seat 2 or 3. Hence Andi is in seat 3 and the full order, from left to right, is Citra, Dira, Andi and Budi.

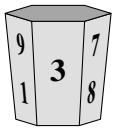
6. My mug has the digits 1 to 9 on it. It can be seen in four of the pictures below.
Which picture shows a different mug?

A 

B

C 

D 

E 

SOLUTION **A**

The diagrams labelled A and C show different mugs as in diagram A the 5 is followed anticlockwise by a 7 and 8 but in diagram C the 5 is followed by a 9 and a 1. Therefore the diagrams labelled B, D and E all show my mug. Hence, going anticlockwise, the numbers on the mug are arranged 9 and 1; 3; 7 and 8 (from diagram E), 4; 2 and 6 (from B); 5. Since the diagram labelled A has the 5 followed by a 7 and 8 anticlockwise, rather than by a 9 and 1, it is diagram A that shows a different mug.

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7. A sports storeroom contains three types of bats: cricket bats, table tennis bats and baseball bats. On Monday, some children each remove two bats chosen at random. What is the smallest number of children who could remove bats to be sure that at least two of them have exactly the same types of bat?

A 8 B 7 C 6 D 5 E 4

SOLUTION **B**

There are six different possible choices of two bats: cricket and cricket; cricket and table tennis; cricket and baseball; table tennis and table tennis; table tennis and baseball; baseball and baseball. Therefore it is possible that six children could have each removed two bats and no two would have had exactly the same. Hence, to be sure that at least two children had the same pair of types of bat, at least seven children would need to have removed bats.

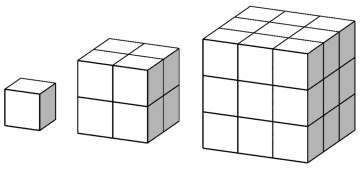
8. Mariam has 13 dollars less than the the total amount that Ria and Emma have. Ria has 5 dollars more than the total amount that Mariam and Emma have. How many dollars does Emma have?

A 18 B 12 C 8 D 7 E 4

SOLUTION **E**

Let the number of dollars Mariam, Ria and Emma have be m, r and e respectively. The information in the question tells us that $m + 13 = r + e$ and $r - 5 = m + e$. Now add these two equations to obtain $m + 13 + r - 5 = r + e + m + e$. This simplifies to $8 = 2e$ and hence $e = 4$. Therefore Emma has 4 dollars.

9. Mirko the mouse has three different-sized blocks of cheese, each made up of identically-sized small cubes, as shown in the diagram. He ate 40% of the first block, 40% of the second and 20% of the third. What percentage of the total amount of cheese did Mirko eat?



A 21% B 22% C 23% D 24%
E 25%

SOLUTION **E**

The first piece of cheese consists of one cube, the second consists of eight cubes and the third consists of 27 cubes. Therefore the amount of cubes of cheese that Mirko ate is $0.4 \times 1 + 0.4 \times 8 + 0.2 \times 27 = 0.4 + 3.2 + 5.4 = 9$. Hence the percentage of the total amount of cheese that Mirko ate is $\frac{9}{1+8+27} \times 100 = \frac{9}{36} \times 100 = 25$.

10. Five junior elves and a senior elf live in a magic forest. Each junior elf eats six cherries a day. Each day, the senior elf eats five more cherries than the mean number of cherries eaten by the six elves.
How many cherries does the senior elf eat each day?

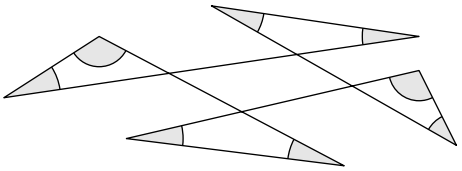
A 10 B 11 C 12 D 13 E 14

SOLUTION **C**

Let the number of cherries eaten by the senior elf each day be y. The information in the question tells us that $y = 5 + \dfrac{y + 5 \times 6}{6}$. Therefore $6y = 30 + y + 30$ and hence $5y = 60$, which has solution $y = 12$. Therefore the senior elf eats 12 cherries each day.

11. What is the sum of the shaded angles?

A 180° B 240° C 270° D 360°
E 450°



SOLUTION **D**

The unmarked angle in each triangle is equal to the vertically opposite angle in the central quadrilateral. The sum of the angles in a quadrilateral is 360° and hence the sum of the four unmarked angles in the four triangles is also 360°. Therefore the sum of the marked angles in the four triangles is $4 \times 180° - 360° = 360°$.

12. There are more than 23 and fewer than 29 people in my class. Everyone likes at least one of Maths or French. Twice as many people like Maths as like French. The same number of people like both Maths and French as like only French. Which of these is the total number of people in my class?

A 24 B 25 C 26 D 27 E 28

SOLUTION **B**

Let the number of people who like both Maths and French be n. Therefore n people like only French and hence $2n$ people like French in total. Since twice as many people like Maths as like French, $4n$ people like Maths in total, Therefore $3n$ people like only Maths.
Since everyone likes either Maths or French, the total number of people in my class is $n + n + 3n = 5n$, which is a multiple of 5. The only multiple of 5 which is more than 23 and less than 29 is 25 and therefore there are 25 people in my class.

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13. The units digit of a number is 1. Julio removes this digit to obtain a new number that is 2026 less than the original number. What is the sum of the digits of the original number?

A 10 B 12 C 14 D 16 E 18

SOLUTION **A**

Let the original number be $10n + 1$. When the units digit is removed, the new number is n. The information in the question tells us that $10n + 1 - 2026 = n$ and hence $9n = 2025$. Therefore $n = 225$ and hence Julio's original number was 2251, which has a digit sum of 10.

14. Two buses left at 08:00, one travelling from Ell to Em and one travelling from Em to Ell, along the same road. The buses both travelled at constant speeds, without stopping. They passed each other at 8:30 and continued along their routes. One bus arrived at its destination at 8:45.
At what time did the other bus arrive at its destination?

A 8:45 B 9:00 C 9:15 D 9:30 E 9:45

SOLUTION **D**

The bus that arrived at its destination at 8:45, travelled the same distance in 15 minutes after the two buses passed each other as the other bus had done in 30 minutes. Therefore the first bus is travelling twice as quickly as the second bus and hence, as the first bus took 30 minutes to get to the point where the buses passed each other, the second bus will take 60 minutes to travel the same distance in reverse. Therefore the second bus will reach its destination 60 minutes after 8:30, when the time is 9:30.

15. In the addition shown, each letter represents a single digit and different letters represent different digits.
What is the value of $L + M + N$?

$$\begin{array}{r} L\ M\ N \\ +\ L\ N\ M \\ \hline N\ 4\ L \end{array}$$

A 16 B 17 C 18 D 19 E 20

SOLUTION **A**

When you consider the hundreds digits in the addition, it can be seen that N is greater than L. Therefore, when you consider the units digits, there will have been a "carry" of 1 to the tens digit column. Hence, considering the tens digits, $M + N + 1 = 14$ and therefore, considering the units digit, $M+N = 13$ and $L = 3$. Therefore the value of $L+M+N$ is $13+3 = 16$.

Note: We have solved the problem as asked without actually finding the values of M and N but, since $L = 3$ and there is a carry into the hundreds column, it is easy to deduce that $N = 7$ and hence that $M = 6$.

16. I have two old watches, my grandfather's watch and my father's watch. My grandfather's watch loses 5 minutes every hour and my father's watch gains 5 minutes every hour. Yesterday, I set them both to the correct time at 09:00 pm. When I woke up the next morning, my grandfather's watch showed 08:00. What time did my father's watch show at that moment?

A 09:00 B 09:30 C 10:00 D 10:30 E 11:00

SOLUTION **C**

In 60 minutes of real time, my grandfather's watch will show that 55 minutes have elapsed and my father's watch will show that 65 minutes have passed. When my grandfather's watch shows that 11 hours, or 660 minutes have passed, the actual number of minutes that will have passed is $\frac{60}{55} \times 660 = 720$, making the real time 09:00. Therefore the number of minutes my father's watch will show have passed is $\frac{65}{60} \times 720 = 780$. Hence my father's watch will show that 13 hours have passed and so will show 10:00.

17. Three kangaroos wanted to share some radishes. Initially, they shared them in the ratio $7 : 6 : 5$ but then changed their minds and shared them in the ratio $6 : 5 : 4$ in the same order. As a result of this change, one kangaroo received four extra radishes. How many radishes did they share?

A 270 B 300 C 360 D 420 E 480

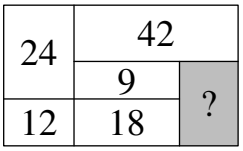
SOLUTION **C**

Initially, the kangaroos shared their radishes into $7 + 6 + 5 = 18$ portions. When they changed their minds, they shared the radishes into $6 + 5 + 4 = 15$ portions. Since $\frac{6}{18} = \frac{5}{15} = \frac{1}{3}$, the second kangaroo received exactly $\frac{1}{3}$ of the radishes each time. Therefore, since the first kangaroo received 1 portion more than the second kangaroo each time and $\frac{1}{18} < \frac{1}{15}$, it is the first kangaroo who received extra radishes the second time.

Let z be the total number of radishes they shared. Therefore $\frac{6}{15}z - \frac{7}{18}z = 4$. The common denominator of 15 and 18 is 90 and hence $\frac{36}{90}z - \frac{35}{90}z = 4$. This simplifies to $\frac{1}{90}z = 4$, which has solution $z = 360$. Therefore the kangaroos shared 360 radishes.

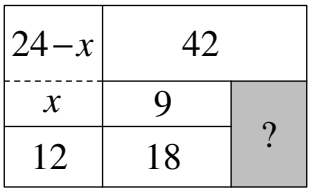
18. The rectangle shown is divided into six rectangular parts. The areas of five of the parts are given. What is the area of the sixth part?

A 14 B 15 C 16 D 18 E 21



SOLUTION **B**

First divide the rectangle of area 24 into two rectangles by extending the horizontal line at the top of the rectangle of area 9, as shown in the diagram.



Let the area of the lower of these two rectangles be x. The rectangles of area 18 and area 9 have equal bases. Therefore their heights are in the same ratio as their areas and hence are in the ratio $18 : 9 = 2 : 1$.

Therefore the rectangles of area 12 and area x also have heights in the ratio $2 : 1$ and, since their bases are equal, we have $12 : x = 2 : 1$ and hence $x = 6$.

Note now that $24 - x = 18$ and that $12 + x = 18$. Hence the horizontal line that was extended divides the large rectangle exactly in half. Therefore the area of the shaded rectangle is $42 - (9 + 18) = 15$.

19. Anna, Bea and Cili went to a store to buy pens and rulers. Each of them bought exactly 10 items in total. Anna bought twice as many pens as Cili bought rulers. Bea bought twice as many pens as Anna bought rulers. Altogether, the girls bought an even number of rulers. How many pens did Bea buy?

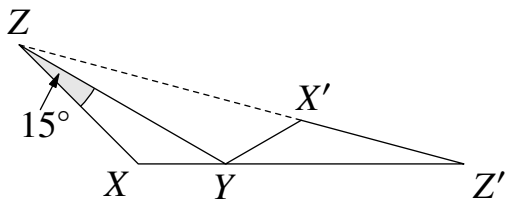
A 2 B 4 C 6 D 7 E 8

SOLUTION **B**

Let the number of rulers Cili bought be n. Since Anna bought twice as many pens as Cili bought rulers, the number of pens Anna bought is $2n$ and the number of rulers she bought is $10 - 2n$. Therefore, since Bea bought twice as many pens as Anna bought rulers, the number of pens Bea bought is $20-4n$ and the number of rulers she bought is $10-(20-4n) = 4n-10$.

We know that all the expressions are non-negative and hence $4n - 10 \geq 0$, which gives $n \geq 2.5$ and $10 - 2n \geq 0$, which gives $n \leq 5$. We also know that the total number of rulers the girls bought is even and hence that $n + (10 - 2n) + (4n - 10) = 3n$ is even. Therefore n is even and, since we have established that $2.5 \leq n \leq 5$, the only possible value for n is 4. Hence the number of pens that Bea bought is $20 - 4 \times 4 = 4$.

20. Triangle $X'YZ'$ is obtained by rotating triangle XYZ around vertex Y. The points Z, X', and Z' lie on a straight line as do X, Y and Z'. The size of $\angle YZX$ is 15°. What is the size of $\angle YXZ$?



A 105° B 115° C 125°
D 135° E 140°

SOLUTION **D**

Since triangle $X'YZ'$ is a rotation of triangle XYZ, the size of $\angle X'Z'Y$ is 15°. Also, $YZ = YZ'$ and hence triangle ZYZ' is isosceles and therefore $\angle YZZ' = \angle YZ'Z = 15°$. Therefore, since the angles in a triangle add to 180°, considering the angles of triangle $XZ'Z$ gives $\angle YXZ + 3 \times 15° = 180°$ and hence the size of $\angle YXZ$ is 135°.

21. A large cube, of side-length 4, is made up from small cubes of side-length 1. What is the smallest number of small cubes that could be removed from the large cube to leave a shape whose surface area is 50% larger than that of the large cube?

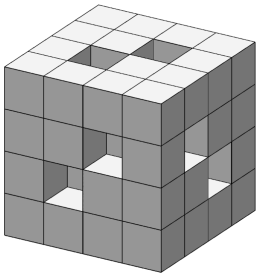
A 6 B 8 C 10 D 12 E 18

SOLUTION **D**

The surface area of the large cube is $6 \times 4 \times 4 = 96$. A shape with a surface area 50% larger than the large cube has a surface area of $1.5 \times 96 = 144$, which is an increase of 48.
Removing a small cube from the corner of the large cube, removes three faces of a small cube from the surface area but reveals a face of three different small cubes. Hence the overall effect on the surface area of removing a small cube from the corner of the large cube is zero.
Removing a small cube from an edge of the large cube, removes two faces of a small cube from the surface area but reveals a face of four different small cubes. Hence the overall effect on the surface area of removing a small cube from the edge of the large cube is to increase the surface area by two.

Removing a small cube from the central part of the face of the large cube, removes one face of a small cube from the surface area but reveals a face of five different small cubes. Hence the overall effect on the surface area of removing a small cube from the central part of the face of a large cube is to increase the surface area by four.

To create a shape with a surface area of 144, the minimum number of small cubes that could be removed is $48 \div 4 = 12$, provided each removed cube increases the surface area by four. This is possible by removing two cubes from each of the six faces of the large cube, arranged as shown in the diagram.



22. How many of the four statements below are true?

1. Exactly two of the statements are false.
2. This statement is true.
3. The previous statement is true.
4. The first three statements are false.

A 0 B 1 C 2 D 3 E 4

SOLUTION **B**

If statement 2 is true then statement 3 is also true. Hence statement 4 would be false and then statement 1 cannot be true or it would contradict itself as there would then be three true statements. Also, statement 1 cannot be false as then would be two true statements, contradicting the assumption that statement 1 is false. Therefore statement 2 is false and hence statement 3 is also false.

Now, if statement 1 were true, statement 4 would also have to be true but this would contradict the truth of statement 1. Therefore statement 1 is also false so the first three statements are false and hence statement 4 is the only statement that is true.

23. Deindra wants to arrange the five numbers 1, 2, 3, 4, and 5 into a row such that the last number is odd, and the sum of any three adjacent numbers is divisible by the first number of the three. How many such arrangements could she make?

A 1 B 2 C 3 D 4 E 5

SOLUTION **E**

Since the sum of any three adjacent numbers must be divisible by the first number of the three and no odd total can be divisible by an even number, we cannot have a set of three adjacent numbers that are even, even, odd or even, odd, even as then their sum would be odd. Hence, since we are told that the last number of the set of five is odd, the only possible arrangement is even, odd, odd, even, odd.

The three odd numbers can be arranged in six different ways and the two even numbers in two different ways, leaving a total of $2 \times 6 = 12$ possible arrangements to be checked, namely 21345, 21543, 23145, 23541, 25143, 25341, 41325, 41523, 43125, 43521, 45123 and 45321. Of these, the ones in which the sum of any three adjacent numbers is divisible by the first number of the three are 21345, 23541, 25143, 43125 and 45321. Hence there are five different arrangements satisfying the condition.

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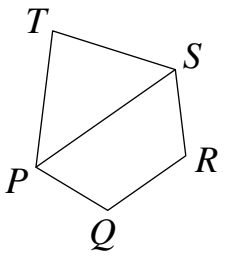
24. The diagram shows a pentagon $PQRST$ with diagonal PS, in which $TP = TS$ and $PQ = RS$. Also PS is parallel to QR but PQ is not parallel to SR.
Angles PTS and PSR are equal, and the ratio of the sizes of $\angle TSP$ and $\angle QPS$ is 3 : 2. What is the size of $\angle SRQ$?



A 135° B 125° C 120° D 115° E 110°

SOLUTION **A**

Let the size of $\angle QPS$ be $2x°$. Therefore the size of $\angle TSP$ is $3x°$. Since we know that PS and QR are parallel and that $PQ = RS$, the trapezium $PSRQ$ is an isosceles trapezium and hence $\angle PSR = \angle QPS = 2x°$. The question tells us that $\angle PTS = \angle PSR$ and hence $\angle PTS = 2x°$. Also, $TP = TS$ and hence triangle TPS is isosceles with $\angle TPS = \angle TSP = 3x°$. Since angles in a triangle add to 180°, we have $3x + 3x + 2x = 180$ and hence $x = 22.5$. Therefore, the size of $\angle PSR$ is 45° and, since co-interior angles in parallel lines add to 180°, the size of $\angle SRQ$ is 135°.

25. Anna, Elsa and their mother are playing a reasoning game. They are sitting round a table on which are the five sweets pictured below. Their mother tells Anna and Elsa that she is thinking of one of the sweets. She tells Anna the pattern on its wrapper and tells Elsa its shape. When she asks "Do you know which sweet I am thinking of?", both Anna and Elsa say "no". The mother then asks "Now, do you know?". Again, both answer "no". However, when the mother asks a third time, both Anna and Elsa together answer correctly. Which sweet was their mother thinking of?

A B C D E

SOLUTION **E**

Since Anna does not know what the selected sweet is immediately, Elsa can deduce that it is not the only sweet with a plain wrapper and so is not sweet B, which Anna already knows. Similarly, when Elsa does not know what the selected sweet is immediately, Anna can deduce that it is not the only sweet that is shaped like a cane and so is not sweet C, which Elsa already knows.
When they are asked a second time and Anna still does not know what the selected sweet is, Elsa can deduce that is not the only sweet remaining with a striped wrapper and so is not sweet D. Similarly, when Elsa still does not know what the selected sweet is, Anna can deduce that it is not the only sweet remaining that is round and so is not sweet A. Hence only sweet E remains and this is the sweet that was selected.

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