United Kingdom Mathematics Trust

Individual Challenge — Past Papers Collection

www.CasperYC.Club/ukmt

Last updated: October 10, 2025

Comments and suggestions to DrYuFromShanghai@QQ.com

Junior Challenge

www.CasperYC.club

Last updated: October 10, 2025

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 questions 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.

Comments and suggestions to DrYuFromShanghai@QQ.com

Answers for UKMT Junior Challenges:

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
1	C	E	E	A	E	B	C	B	C	D	B	B	B	E	E	D	A	B	E	C	A	E	A	1
2	C	B	C	D	D	E	B	A	D	E	B	E	E	C	E	B	E	A	D	D	E	D	E	2
3	A	B	A	C	A	A	C	C	B	B	D	A	B	E	C	C	D	E	D	A	A	C	A	3
4	C	D	C	D	B	D	E	C	E	C	E	D	C	C	C	E	A	C	E	E	E	B	D	4
5	A	A	C	A	C	C	B	B	E	E	D	D	B	D	D	A	B	A	C	A	C	E	E	5
6	B	D	D	A	B	E	D	D	A	D	B	C	E	D	A	A	B	C	D	D	B	C	B	6
7	D	C	A	C	C	C	C	A	D	C	C	A	D	B	D	B	A	A	A	B	A	A	C	7
8	E	C	E	E	E	E	A	E	D	A	E	D	A	B	A	A	C	A	B	D	A	D	E	8
9	C	E	B	C	B	C	E	E	C	E	A	A	A	C	B	E	D	E	D	C	B	A	E	9
10	A	B	A	E	D	B	D	D	D	B	B	E	C	E	E	D	E	D	E	C	E	D	C	10
11	C	D	E	E	B	D	A	B	A	E	C	C	C	B	C	D	D	C	B	D	D	E	C	11
12	E	D	B	C	A	B	E	C	A	C	A	C	E	B	E	B	B	B	D	A	D	B	D	12
13	D	B	D	A	D	A	A	A	D	C	D	B	E	C	D	A	A	C	C	D	E	B	B	13
14	D	E	E	B	C	C	D	C	E	D	E	D	A	A	B	D	E	D	B	E	D	D	A	14
15	C	A	C	D	C	D	A	D	C	B	E	C	A	E	A	E	C	E	A	D	E	E	D	15
16	D	D	B	C	D	C	D	C	B	A	D	E	B	D	B	E	D	B	D	E	C	A	B	16
17	E	D	D	B	E	D	E	D	C	B	A	D	D	A	E	C	B	C	B	B	D	E	C	17
18	B	C	B	D	D	B	A	A	B	B	B	D	C	D	A	E	B	D	A	B	C	B	C	18
19	E	B	C	D	D	B	E	D	A	D	A	C	D	E	D	C	D	B	A	C	B	E	D	19
20	E	E	D	B	C	A	B	E	E	A	D	B	A	A	B	B	C	A	B	B	E	D	E	20
21	D	A	E	A	C	E	D	A	B	A	E	C	B	B	C	D	C	A	C	D	D	D	B	21
22	D	C	E	D	E	D	C	B	D	D	D	E	D	B	E	C	E	E	B	B	A	E	A	22
23	B	A	B	C	A	E	B	B	E	B	C	E	E	A	D	D	D	B	E	A	B	B	E	23
24	A	B	A	E	B	A	C	C	C	E	C	B	D	D	B	C	B	D	E	B	B	B	D	24
25	D	D	D	B	A	D	B	B	B	D	B	A	C	A	C	A	E	D	E	D	D	E	B	25
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	

Comments and suggestions to DrYuFromShanghai@QQ.com

1. When the five expressions below are simplified, how many different values are obtained?

$$2+2 \qquad 2\times 2 \qquad 2-2 \qquad 2\div 2 \qquad 2^2$$

A 1 B 2 C 3 D 4 E 5

2. Which of the following could have a capacity of 10 litres?

A An aeroplane B A bucket C A cup D A dustpan E An egg

3. Gill is 36 this year. In which year will her age next be a square?

A 2025 B 2037 C 2047 D 2052 E 2060

4. A drink is made by mixing one part of cordial with four parts of water. What percentage of the drink is cordial?

A 20 B 25 C 40 D 75 E 80

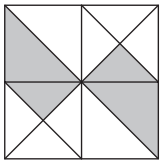
5. What is the value of $1+2-3\times 4\div 5$?

A 0.2 B 0.3 C 0.4 D 0.5 E 0.6

6. Which of the following has the same remainder when divided by 3 as it does when divided by 4?

A 7 B 11 C 17 D 19 E 25

7. The diagram shows a large square which has been divided into four smaller squares. It also shows both diagonals of the large square and two diagonals of smaller squares. What fraction of the area of the large square has been shaded?

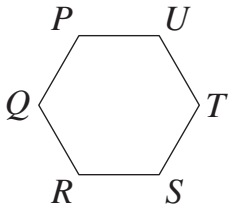


A $\frac{3}{16}$ B $\frac{1}{4}$ C $\frac{5}{16}$ D $\frac{3}{8}$ E $\frac{7}{16}$

8. Skye has half as many pens as Ishaa. Ana has twice as many pens as Skye. What fraction of all their pens does Skye have?

A $\frac{1}{3}$ B $\frac{1}{4}$ C $\frac{1}{5}$ D $\frac{1}{6}$ E $\frac{1}{8}$

9. The diagram shows the regular hexagon $PQRSTU$.



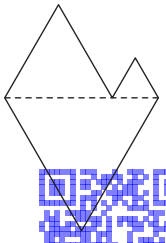
What is the size of angle UPT?

A 30° B 45° C 60° D 120° E 150°

10. In Fred's field there are some humans and some horses. There are 25 heads in total and 60 legs in total. What is the difference between the number of humans and the number of horses?

A 3 B 7 C 9 D 11 E 15

11. A hexagon is formed by arranging three equilateral triangles, as shown in the diagram. The side-length of the largest equilateral triangle is 10 cm. What is the perimeter, in cm, of the hexagon?



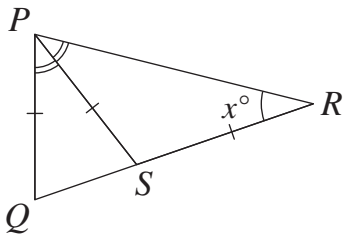
A 45 B 40 C 35 D 30
E more information needed

12. In the multiplication sum shown, y represents the same digit each time.
What is the value of y?

$$\begin{array}{r} 3\ y \\ \times\ \ 4\ y\ y \\ \hline 1\ y\ 7\ 7\ y \end{array}$$

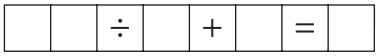
A 0 B 1 C 4 D 5 E 6

13. In the triangle PQR, the point S is on the edge QR.
$\angle QPS = \angle SPR$, $PQ = PS = SR$ and $\angle PRQ = x°$.
What is the value of x?



A 30 B 33 C 36 D 40 E 45

14.

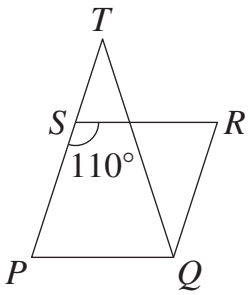


The digits 1, 2, 3, 5 and 8 are to be placed in the grid above, one to a cell, to make a correct mathematical statement. Which number should come immediately after the division sign?

A 1 B 2 C 3 D 5 E 8

15. In the diagram shown, $PQRS$ is a rhombus and PQT is an isosceles triangle in which $PT = QT$. Angle $PSR = 110°$.

What is the size of angle SQT?

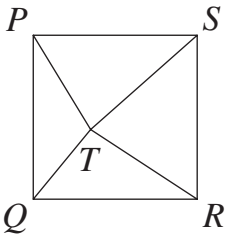


A 5° B 10° C 12.5° D 15° E 20°

16. The world's smallest vertebrate is much shorter than its name! Discovered in 2022, the frog *paedophryne amauensis* is only 7.7 mm long.
Approximately how many of these frogs, placed end to end, would be needed to make a line 1 metre long?

A 100 B 130 C 260 D 390 E 520

17. $PQRS$ is a square with area 100 cm^2. The point T is inside the square.
QRT is a triangle with area 24 cm^2.
What is the area, in cm^2, of the triangle PTS ?



A 24 B 25 C 26 D 27 E 28

18. Goldilocks eats three equal-sized bowls of porridge, one after the other. When she has eaten $\frac{3}{7}$ of the total amount of porridge, what fraction of the porridge in the second bowl has she eaten?

A $\frac{2}{63}$ B $\frac{1}{7}$ C $\frac{1}{3}$ D $\frac{2}{7}$ E $\frac{1}{2}$

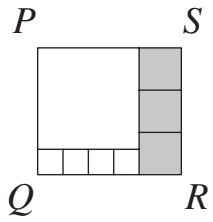
19. Jokers always lie.
Clowns always tell the truth.
A group of four, each of whom is a Joker or a Clown, make the following statements about each other:
P says, "Q always lies"; Q says, "R always lies";
R says, "P always tells the truth"; S says, "Exactly two of P, Q and R are Jokers".
How many of P, Q, R and S are Clowns?

A 0 B 1 C 2 D 3 E 4

20. When you cut a regular hexagon into two pieces with a single straight cut, you get two polygons. Which of these shapes cannot be obtained?

A A triangle B A quadrilateral C A pentagon D A heptagon
E An octagon

21. The rectangle $PQRS$ is divided into eight squares: one large unshaded square, four small unshaded squares and three shaded squares, as shown in the diagram. What fraction of the area of rectangle $PQRS$ is shaded?



A $\frac{1}{5}$ B $\frac{5}{17}$ C $\frac{2}{7}$ D $\frac{3}{10}$ E $\frac{1}{3}$

22. Forty furry ferrets weigh the same as fifty fit ferrets. Forty-five fit ferrets weigh the same as fifty-four friendly ferrets. How many friendly ferrets weigh the same as fifty furry ferrets?

A 40 B 55 C 60 D 75 E 80

23. The area of a square is six times the area of a rectangle with a length half that of the square and a width 6 cm less than the width of the square. What is the perimeter of the square?

A 24 cm B 28 cm C 32 cm D 36 cm E 40 cm

24. Rovers, United, City and Wanderers played against each other once in a hockey tournament.

The results table is shown on the right:

Team	Win	Draw	Loss	Goals for	Goals against
Rovers	3	0	0	5	0
United	0	2	1	3	6
City	1	1	1	4	4
Wanderers	0	1	2	0	2

What was the score in the match between Rovers and United?

A 3 - 1 B 3 - 0 C 2 - 1 D 2 - 0 E 1 - 0

25. In a school, one fifth of the students have blue eyes. One tenth of the left-handed students have blue eyes. One quarter of the right-handed students have blue eyes. What fraction of the students are left-handed?

A $\frac{1}{3}$ B $\frac{1}{4}$ C $\frac{1}{5}$ D $\frac{1}{8}$ E $\frac{1}{10}$

1. What is the value of $3202 - 2023$?

A 821 B 1001 C 1179 D 1221 E 1279

2. How many of the following five options are factors of 30?

A 1 B 2 C 3 D 4 E 5

3. What is the value of $\dfrac{1+2+3+4+5}{6+7+8+9+10}$?

A $\frac{1}{2}$ B $\frac{3}{8}$ C $\frac{7}{16}$ D $\frac{9}{20}$ E $\frac{1}{3}$

4. One of these is the largest two-digit positive integer that is divisible by the product of its digits. Which is it?

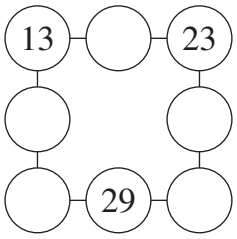
A 12 B 24 C 36 D 72 E 96

5. The record for travelling 100m on a skateboard by a dog is 19.65 seconds. This was achieved by Jumpy in 2013. What was Jumpy's approximate average speed?

A 0.2 m/s B 0.5 m/s C 2 m/s D 2.5 m/s E 5 m/s

6. When this prime number square is completed, the eight circles contain eight different primes, and each of the four sides has total 43.
What is the sum of the five missing primes?

A 51 B 53 C 55 D 57 E 59



7. What is the difference between the largest two-digit multiple of 2 and the smallest three-digit multiple of 3?

A 5 B 4 C 3 D 2 E 1

8. How many of these six numbers are prime?

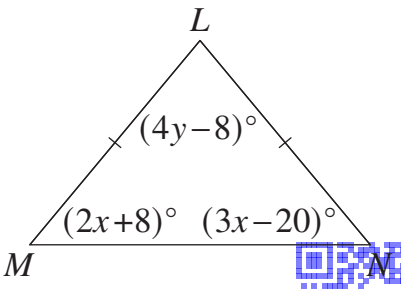
0^2+1^2	1^2+2^2	2^2+3^2	3^2+4^2	4^2+5^2	5^2+6^2

A 1 B 2 C 3 D 4 E 5

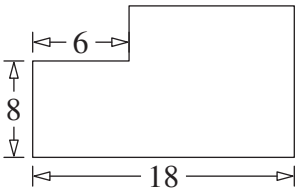
9. Triangle LMN is isosceles with $LM = LN$.

What is the value of y?

A 15 B 17 C 19 D 21 E 23



10. In the diagram, all distances shown are in cm. The perimeter of the shape is 60 cm. What is the area, in cm^2, of the shape?



A 192 B 204 C 212 D 232 E 252

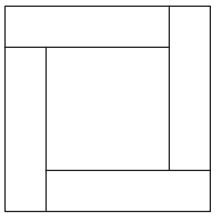
11. To save money, Scrooge is reusing tea bags. After a first 'decent' cup of tea, he dries the bag and uses two such dried bags to make a new 'decent' cup of tea. These bags are then dried again and four such bags now make a 'decent' cup of tea. After that they are put on the compost heap.
How many 'decent' cups of tea can Scrooge get out of a new box of 120 tea bags?

A 480 B 240 C 210 D 195 E 180

12. One afternoon, Brian the snail went for a slither at a constant speed. By 1:50 pm he had slithered 150 centimetres. By 2:10 pm he had slithered 210 centimetres. When did Brian start his slither?

A Noon B 12:20 pm C 12:30 pm D 12:45 pm E 1 pm

13. Four congruent rectangles are arranged as shown to form an inner square of area $20\,\text{cm}^2$ and an outer square of area $64\,\text{cm}^2$.
What is the perimeter of one of the four congruent rectangles?



A 6 cm B 8 cm C 9.75 cm D 16 cm E 20 cm

14. In the addition shown, x and y represent different single digits.
What is the value of $x + y$?

$$\begin{array}{r} 7\ 7\ x \\ 6\ y\ x \\ +\ y\ y\ x \\ \hline 1\ x\ x\ 7 \end{array}$$

A 10 B 11 C 12 D 13 E 14

15. My train was scheduled to leave at 17:48 and to arrive at my destination at 18:25. However, it started four minutes late, and the journey took twice as long as scheduled.
When did I arrive?

A 19:39 B 19:06 C 19:02 D 18:29 E 17:52

16. Amrita needs to select a new PIN. She decides it will be made up of four non-zero digits with the following properties:

i) The first two digits and the last two digits each make up a two-digit number which is a multiple of 11.
ii) The sum of all the digits is a multiple of 11.

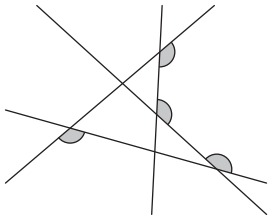
How many different possibilities are there for Amrita's PIN?

A 1 B 2 C 4 D 8 E 16

17. Two numbers p and q are such that $0 < p < q < 1$.
Which is the largest of these expressions?

A $q - p$ B $p - q$ C $\dfrac{p+q}{2}$ D $\dfrac{p}{q}$ E $\dfrac{q}{p}$

18. What is the sum of the four marked angles in the diagram?

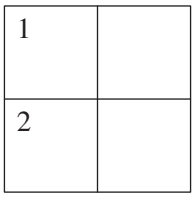


A 540° B 560° C 570° D 600° E 720°

19. In a football match, Rangers beat Rovers 5 – 4. The only time Rangers were ahead was after they scored the final goal. How many possible half-time scores were there?

A 9 B 10 C 15 D 16 E 25

20. Each cell in the crossnumber is to be filled with a single digit.



Across	**Down**
1. A cube	1. A prime
2. A square	

Which of these could be the sum of the four digits in the crossnumber?

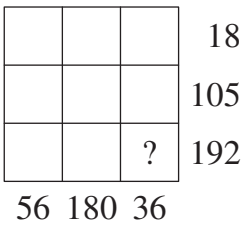
A 17 B 16 C 15 D 14 E 13

21. Eleanor's Elephant Emporium has four types of elephant. There are twice as many grey elephants as pygmy elephants, three times as many white elephants as grey elephants and four times as many pink elephants as white elephants. There are 20 more white elephants than pygmy elephants.
How many elephants are in Eleanor's Emporium?

A 123 B 132 C 213 D 231 E 312

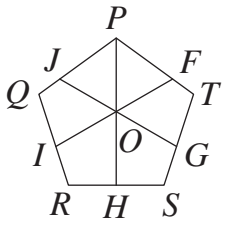
22. The positive integers from 1 to 9 inclusive are placed in the grid, one to a cell, so that the product of the three numbers in each row or column is as shown.
What number should be placed in the bottom right-hand cell?

A 9 B 6 C 4 D 3 E 2



23. Regular pentagon $PQRST$ has centre O. Lines PH, FI and GJ go through O. The six angles at O are equal.
What is the size of angle TGO?

A 60° B 72° C 75° D 76° E 78°



24. Beatrix was born in this century. On her birthday this year, her age was equal to the sum of the digits of the year in which she was born. In which of these years will her age on her birthday be twice the sum of the digits of that year?

A 2027 B 2029 C 2031 D 2033 E 2035

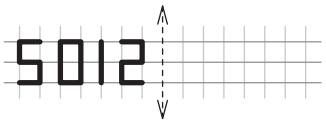
25. Granny gave away her entire collection of antique spoons to three people. Her daughter received 8 more than a third of the total; her son received 8 more than a third of what was then left; finally her neighbour received 8 more than a third of what was then left.
What is the sum of the digits of the number of spoons which were in Granny's collection?

A 14 B 12 C 10 D 8 E 6

1. Which of these has the greatest value?

A $20+22$ B $202+2$ C 202×2 D $2\times 0\times 2\times 2$ E 20×22

2. The number 5012 is reflected in the mirror-line shown.
Onto which number is it reflected?



A 5102 B 2015 C 5012 D 2105 E 5105

3. Think of any number. Add five; multiply by two; add ten; divide by two; subtract your original number; add three. What is the resulting number?

A 10 B 11 C 12 D 13 E 14

4. What is the value of $0.6+\frac{2}{5}$?

A 0.15 B 0.24 C 0.8 D 1 E 2.4

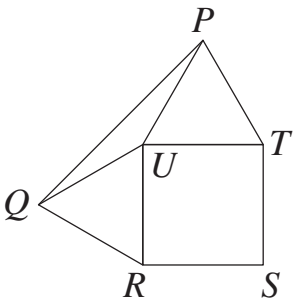
5. How many of the following take integer values?

$$\frac{1}{1} \quad \frac{11}{1+1} \quad \frac{111}{1+1+1} \quad \frac{1111}{1+1+1+1} \quad \frac{11\,111}{1+1+1+1+1}$$

A 0 B 1 C 2 D 3 E 4

6. The diagram shows the square $RSTU$ and two equilateral triangles, PUT and QRU.

What is the size of angle QPU?



A 10° B 15° C 20° D 25° E 30°

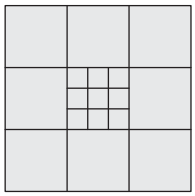
7. Kiwi fruit contain roughly two and a half times as much vitamin C as the same weight of oranges. What weight of kiwi fruit contains approximately the same amount of vitamin C as 1 kg of oranges?

A 100 g B 200 g C 250 g D 400 g E 550 g

8. Today is Thursday. What day will it be in 100 days' time?

A Tuesday B Wednesday C Thursday D Friday E Saturday

9. How many squares of any size can be seen in the diagram?



A 25 B 27 C 28 D 39 E 40

10. Half of a quarter of an eighth of a number is equal to $\frac{1}{2}+\frac{1}{4}+\frac{1}{8}$.
What is the number?

A 14 B 28 C 42 D 56 E 64

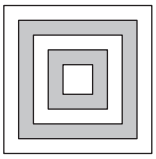
11. Nine of the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 are to be put in two groups so that the sum of the numbers in each group is a multiple of four.
What is the largest number that could be left out?

A 3 B 4 C 5 D 6 E 7

12. When my pot of paint is half full, it weighs 5.8 kg. When my pot of paint is one quarter full, it weighs 3.1 kg. What is the weight of the full pot?

A 8.9 kg B 11.2 kg C 11.6 kg D 12 kg E 12.4 kg

13. The diagram shows five squares whose side-lengths, in cm, are 1, 2, 3, 4 and 5.
What percentage of the area of the outer square is shaded?



A 25% B 30% C 36% D 40% E 42%

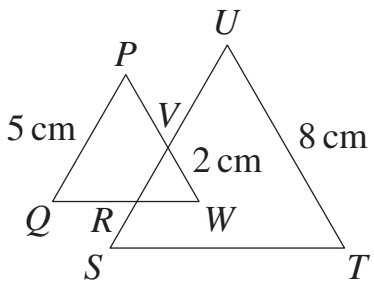
14. A group of children stand evenly spaced around a circular ring and are numbered consecutively 1, 2, 3, and so on. Number 13 is directly opposite number 35. How many children are there in the ring?

A 42 B 44 C 46 D 48 E 50

15. What is the value of $2 \div (4 \div (6 \div (8 \div 10)))$?

A $\frac{1}{960}$ B $\frac{1}{5}$ C $\frac{3}{8}$ D $\frac{1}{2}$ E $\frac{15}{4}$

16. The diagram shows a seven-sided polygon, $PQRSTUV$. It is formed from two equilateral triangles PQW and STU of side-length 5 cm and 8 cm respectively. The two triangles overlap in an equilateral triangle of side-length 2 cm.
What is the perimeter of $PQRSTUV$?

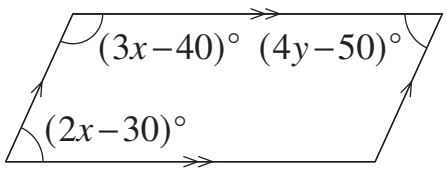


A 27 cm B 30 cm C 33 cm D 36 cm
E 39 cm

17. Amrita and Beatrix play a game in which each player starts with 10 counters. In each round of the game, one player wins and is given 3 counters; and her opponent has 1 counter removed. At the end of the game, Amrita and Beatrix have 40 counters and 16 counters respectively.
How many rounds of the game did Amrita win?

A 10 B 11 C 12 D 13 E 14

18. The diagram shows a parallelogram.
What is the value of y?



A 22 B 24 C 25 D 28 E 30

19. At the start of the day I had three times as many apples as pears. By the end of the day, after eating five apples but no pears, I had twice as many pears as apples.
How many pieces of fruit did I have at the start of the day?

A 4 B 8 C 12 D 16 E 20

20. During a particularly troublesome lesson, the following conversation occurs:
Pam: "I always tell the truth." Quentin: "Pam is lying."
Roger: "Both Pam and Quentin are lying." Susan: "Everyone is lying."
Terry: "Everyone is telling the truth."

How many people are telling the truth?

A 0 B 1 C 2 D 3 E 4

21. Two lists of numbers are as shown below.

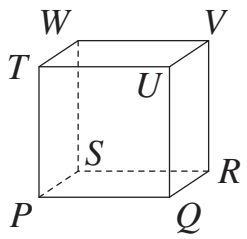
List S:	3	5	8	11	13	14
List T:	2	5	6	10	12	13

Jenny decided she would move one number from List S to List T and one number from List T to List S so that the sum of the numbers in the new List S is equal to the sum of the numbers in the new List T. In how many ways could she do this?

A 1 B 2 C 3 D 4 E 5

22. A triangular pyramid with vertices T, U, V and Q is removed from the solid cube shown.
How many edges does the remaining solid have?

A 4 B 6 C 8 D 10 E 12



23. The price of a train ticket increased by 5% and then decreased by 20% in a special offer. It was then £4 less expensive than its original price. What was the original price of the ticket?

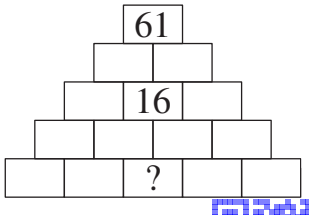
A £8.60 B £13 C £20.40 D £25 E £26.40

24. Flori's Flower shop contains fewer than 150 flowers. All the flowers are purple, yellow, red or white. The ratio of purple flowers to yellow flowers is 1 : 2, the ratio of yellow flowers to red flowers is 3 : 4 and the ratio of red flowers to white flowers is 5 : 6.
How many flowers are there in Flori's shop?

A 133 B 136 C 139 D 142 E 145

25. In the number pyramid shown, each cell above the bottom row contains the sum of the numbers in the two cells immediately below it. The sum of the numbers in the bottom row is 17.
What is the central number of the bottom row?

A 2 B 3 C 4 D 5 E 6



Intermediate Challenge

www.CasperYC.club

Last updated: October 10, 2025

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.

Comments and suggestions to DrYuFromShanghai@QQ.com

Answers for UKMT Intermediate Challenges:

	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	
2024	D	A	A	D	C	C	B	C	D	B	C	D	C	B	B	D	E	E	A	D	E	E	B	C	E	2024
2023	D	A	B	D	B	E	B	E	B	D	B	E	A	C	A	A	C	B	E	B	A	E	D	C	D	2023
2022	B	A	B	D	C	D	E	A	E	C	E	A	C	D	E	D	C	B	A	D	B	D	E	B	C	2022
2021	B	A	C	A	D	E	C	B	D	D	E	E	A	B	D	E	D	C	A	B	D	E	B	B	E	2021
2020	A	E	B	D	D	C	B	E	E	B	E	B	C	A	A	E	E	C	B	D	B	C	A	A	A	2020
2019	B	E	D	B	D	B	B	E	C	B	C	C	A	C	A	A	D	B	E	B	D	E	A	C	D	2019
2018	B	B	C	D	B	A	B	A	E	E	B	E	C	C	E	C	D	A	D	E	D	E	A	B	D	2018
2017	D	B	A	D	B	D	C	D	B	A	E	D	A	B	C	D	B	E	E	D	A	C	D	C	A	2017
2016	B	D	B	E	A	C	C	E	C	E	D	D	B	D	A	B	B	C	B	D	A	E	B	C	D	2016
2015	A	E	E	C	B	D	E	B	B	C	D	D	A	C	C	D	D	A	A	C	D	B	B	E	D	2015
2014	A	D	E	C	E	E	B	C	A	B	C	D	B	B	E	C	D	B	C	D	D	B	A	A	E	2014
2013	D	B	E	D	E	E	A	D	A	C	C	D	B	D	B	A	D	C	E	B	B	D	A	B	D	2013
2012	B	D	E	C	D	A	C	A	B	D	C	B	D	A	E	B	E	C	A	D	A	E	C	D	B	2012
2011	B	A	E	E	C	B	A	E	A	E	E	D	D	E	A	C	C	D	B	D	B	B	A	C	D	2011
2010	D	A	E	A	E	C	D	B	C	C	B	D	B	C	E	E	A	A	B	D	E	E	B	B	D	2010
2009	B	D	C	A	D	A	C	A	B	D	E	D	A	E	B	B	D	B	E	D	E	D	C	C	E	2009
2008	E	C	B	B	D	B	D	A	D	C	E	C	D	B	A	D	D	C	E	A	B	A	E	C	E	2008
2007	D	C	E	E	D	A	B	B	B	C	A	A	E	A	D	D	C	C	E	C	B	A	C	D	E	2007
2006	C	B	D	E	B	A	D	C	D	B	C	D	E	D	A	B	E	E	B	D	A	B	B	C	D	2006
2005	E	D	A	B	C	D	B	A	D	C	C	B	D	C	A	B	C	E	C	D	E	A	E	A	B	2005
2004	D	E	E	C	B	B	D	D	E	E	A	A	C	B	D	C	B	E	D	C	D	A	C	A	B	2004
2003	E	D	A	C	E	D	C	D	E	C	B	B	C	A	E	C	A	E	B	D	D	C	A	B	A	2003
2002	D	D	C	B	E	C	B	D	B	C	D	A	E	E	D	C	B	A	A	A	D	C	E	C	B	2002
2001	A	E	A	E	C	D	C	A	D	B	B	E	B	D	C	B	C	E	E	D	A	C	B	D	D	2001
2000	B	A	E	C	C	B	D	C	B	D	D	E	B	D	C	A	D	D	C	C	E	C	B	A	A	2000
1999	C	B	D	E	D	A	E	D	E	D	D	A	B	E	C	E	C	B	C	B	A	D	E	A	B	1999
	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	

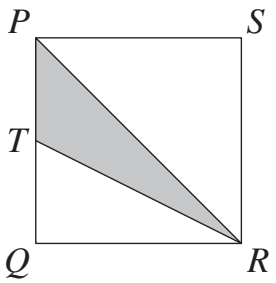
1. What is the value of $\dfrac{20+24}{20-24}$?

A 8 B -9 C 10 D -11 E 12

2. What is the difference between the smallest two-digit prime and the largest two-digit prime?

A 86 B 84 C 82 D 80 E 78

3. The diagram shows the square $PQRS$ and T, the mid-point of the side PQ. What fraction of the area of the square $PQRS$ is shaded?



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

4. The shorter sides of a right-angled triangle have lengths $\sqrt{5}$ and $\sqrt{12}$. What is the length of the hypotenuse?

A $\sqrt{7}$ B $\sqrt{13}$ C $\sqrt{15}$ D $\sqrt{17}$ E 7

5. The ages of Grannie's seven grandchildren are consecutive positive integers. The youngest three grandchildren have a mean age of 6. What is the mean age of the oldest three grandchildren?

A 8 B 9 C 10 D 11 E 12

6. Four of these points lie on a circle. Which of the points does not lie on that circle?

A (5, 0) B (4, 3) C (2, 2) D (3, 4) E (0, 5)

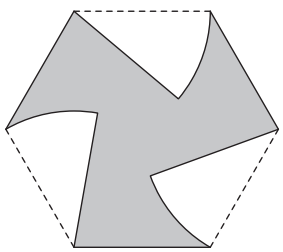
7. The 'Penny's Puddings' company uses one tonne of rice to make twenty-five thousand cans of rice pudding. Each tonne of rice contains approximately fifty million grains of rice. Approximately how many grains of rice are there in a can of Penny's rice pudding?

A 200 B 2000 C 5000 D 50 000 E 1 250 000

8. What is the value of $999 \times 999 + 999$?

A 10 800 B 100 800 C 999 000 D 999 999 E 1 000 998

9. Three sectors of a circle are removed from a regular hexagon to form the shaded shape shown. Each sector has perimeter 18 mm. What is the perimeter, in mm, of the shaded shape formed?

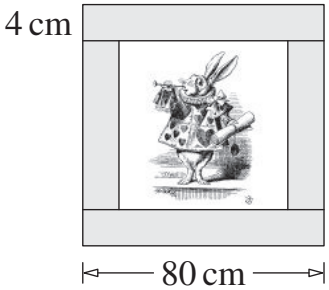


A 48 B 50 C 52 D 54 E 56

10. Which of the following is equal to $\frac{20}{24}+\frac{20}{25}$?

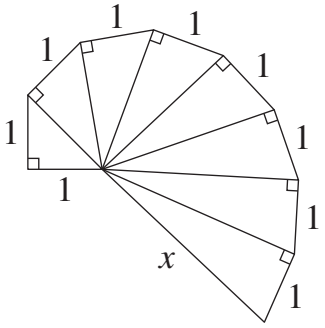
A $\frac{40}{600}$ B $\frac{49}{30}$ C $\frac{30}{49}$ D $\frac{40}{49}$ E $\frac{49}{40}$

11. A picture, together with its frame, makes a square of side-length 80 cm.
The frame is 4 cm wide.
What percentage of the area of the square is covered by the frame?



A 15% B 18% C 19% D 20% E 24%

12. What is the length of the line segment marked x?



A $\sqrt{2}$ B 2 C $2\sqrt{2}$ D 3 E 4

13. When I increase a certain number by 20%, I get twice as much as when I decrease 20 less than the number by 20%. What is that number?

A 40 B 60 C 80 D 100 E 120

14. Going clockwise around a quadrilateral, its interior angles are in the ratio 6 : 7 : 8 : 9.
Which of the following is a true statement about the quadrilateral?

A It has a right angle B It is a trapezium C It is a parallelogram
D It is a kite E It is cyclic

15. Carrie the cat and Barrie the bat together weigh 4000 g more than Rollie the rat.
Barrie and Rollie together weigh 2000 g less than Carrie.
Carrie and Rollie together weigh 3000 g more than Barrie.
What is the weight, in grams, of Rollie the rat?

A 250 B 500 C 750 D 1000 E 1250

16. Factorial n, written $n!$, is defined by: $n! = 1 \times 2 \times 3 \times \cdots \times n$.
What is the remainder when $1! + 2! + 3! + 4! + 5! + 6! + 7! + 8! + 9! + 10!$ is divided by 5?

A 0 B 1 C 2 D 3 E 4

17. What is $4^{(3^2)}$ divided by $(4^3)^2$?

A 1 B 6 C 16 D 32 E 64

18. The point $P\ (-1, 4)$ is reflected in the y-axis to become Q. The point Q is reflected in the line $y = x$ to become R. The point R is reflected in the x-axis to become S.
What is the area of quadrilateral $PQRS$?

A 4 B $4\sqrt{2}+2$ C 6 D $4+2\sqrt{2}$ E 8

19. In the grid shown the three non-zero numbers in each row, each column and each diagonal *multiply* to give the same *product*.
What is the value of x?

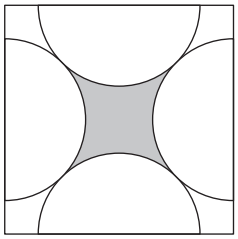
	6	
2	x	3

A 36 B 18 C 12 D 9 E 4

20. A shop sign says, "T-shirts. Three for the price of two. Equivalent to a saving of £5.50 on each T-shirt." Using this special offer, what is the cost of three T-shirts?

A £16.50 B £22 C £31 D £33 E £49.50

21. The diagram shows a square of side 4 cm with four identical semi-circles drawn with their centres at the mid-points of the sides. The four semi-circles each touch two other semi-circles, as shown.
What is the shaded area, in cm^2?

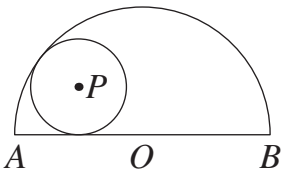


A $8-\pi$ B π C $\pi-2$ D $\pi-\sqrt{2}$ E $8-2\pi$

22. When a cube is cut into two pieces with a single plane cut, two polyhedra are obtained.
Which of these polyhedra *cannot* be obtained in this way?

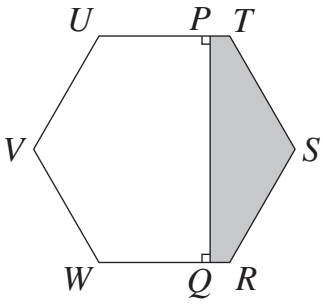
A A polyhedron with 4 faces B A polyhedron with 5 faces C A polyhedron with 6 faces
D A polyhedron with 7 faces E A polyhedron with 8 faces

23. A circle is inscribed in a semicircle with centre O and diameter AB. The centre of the circle is the point P, where $PA = PO$.
What is the ratio of the radius of the circle to the radius of the semicircle?



A 4 : 9 B 3 : 8 C 3 : 7 D 2 : 5 E 1 : 2

24. The diagram shows a regular hexagon $RSTUVW$.
The area of the shaded pentagon $RSTPQ$ is one quarter of the area of the hexagon. Jay and Kay walk around the hexagon from P to Q, Jay going clockwise and Kay anticlockwise.
What is the ratio of the distance Jay walks to the distance Kay walks?



A 1 : 2 B 2 : 3 C 3 : 5 D 4 : 7 E 5 : 8

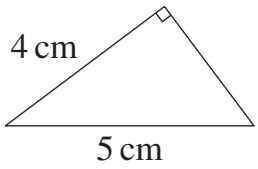
25. A gold coin is worth x% more than a silver coin. The silver coin is worth y% less than the gold coin. Both x and y are positive integers. How many possible values for x are there?

A 0 B 3 C 6 D 9 E 12

1. Which of these numbers is neither a multiple of 3, nor a multiple of 4?

A 16 B 21 C 28 D 34 E 45

2. What is the area of this triangle?

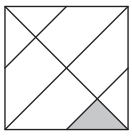


A $6\,\text{cm}^2$ B $7.5\,\text{cm}^2$ C $8\,\text{cm}^2$ D $10\,\text{cm}^2$ E $12\,\text{cm}^2$

3. What is the value of $1-(2-(3-4-(5-6)))$?

A -2 B -1 C 0 D 1 E 2

4. The diagram shows a square, its two diagonals and two line segments, each of which connects two midpoints of sides of the square.



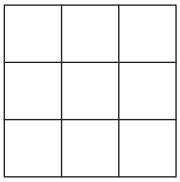
What fraction of the area of the square is shaded?

A $\frac{1}{8}$ B $\frac{1}{10}$ C $\frac{1}{12}$ D $\frac{1}{16}$ E $\frac{1}{24}$

5. We know that $1+2+3+4=10$. It is also true that $1^3+2^3+3^3+4^3=10^n$ for some integer n. What is this integer?

A 1 B 2 C 3 D 4 E 5

6. To draw a 3 by 3 square grid you need 8 straight lines, as shown.



How many straight lines do you need to draw a n by n square grid?

A $n+5$ B $3n-1$ C n^2-1 D $4(n-1)$ E $2(n+1)$

7. What is 0.015% of 60 million?

A 900 B 9000 C 90 000 D 900 000 E 9 000 000

8. $\sqrt{\sqrt{x}}=3$. What is the value of x?

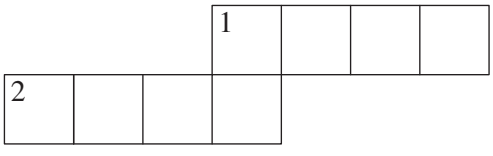
A $\sqrt{\sqrt{3}}$ B $\sqrt{3}$ C 9 D 12 E 81

9. Merryn wrote down the numbers 2, 0, 2, 3 and one further number. What was the median of her five numbers?

A 0 B 2 C 2.5 D 3
E more information required

10.

Across	**Down**
1. A power of 5	1. A power of 6
2. A power of 4	



Eight of the digits from 0 to 9 inclusive are used to fill the cells of the crossnumber. What is the sum of the two digits which are not used?

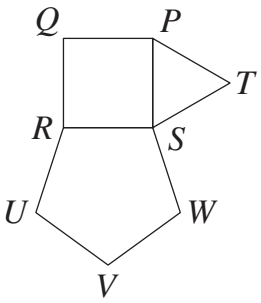
A 12 B 13 C 14 D 15 E 16

11. Jill was given a large jar of jam. She gave one sixth of the jam to Jan. Jill then gave one thirteenth of the remaining jam to Jas. Jill was left with 1 kg of jam.
What was the weight, in kg, of the jam in Jill's jar at the start?

A 1.2 B 1.3 C 1.4 D 1.6 E 1.9

12. In the diagram, $PQRS$ is a square, PST is an equilateral triangle and $SRUVW$ is a regular pentagon.

What is the size of angle WTS?



A 35° B 36° C 37° D 38° E 39°

13. The mean of p and q is 13; the mean of q and r is 16; the mean of r and p is 7.
What is the mean of p, q and r?

A 12 B 13 C 14 D 15 E 16

14. A regular octagon $PQRSTUVW$ has sides of length 2 cm. When I shade the rectangles $PQTU$ and $RSVW$, four small triangles inside the octagon remain unshaded. What is the total area, in cm^2, of these four triangles?

A 1 B 2 C 4 D 6 E 8

15. How many of the following polygons could exist?

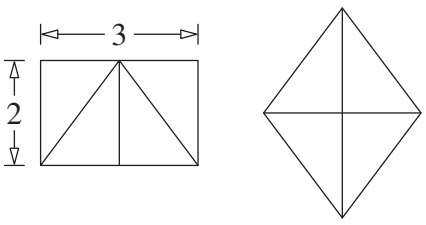
A triangle with all three sides the same length, but three different interior angles.
A quadrilateral with all four sides the same length, but four different interior angles.
A pentagon with all five sides the same length, but five different interior angles.

A only the pentagon
B only the quadrilateral
C the quadrilateral and the pentagon
D all three
E none of them

16. The sum of the lengths of the three sides of a right-angled triangle is 16 cm. The sum of the squares of the lengths of the three sides of the triangle is 98 cm^2.
What is the area, in cm^2, of the triangle?

A 8 B 10 C 12 D 14 E 16

17. A 3 by 2 rectangle is split into four congruent right-angled triangles, as shown in the left-hand diagram.
Those four triangles are rearranged to form a rhombus, as shown in the right-hand diagram.
What is the ratio of the perimeter of the rectangle to the perimeter of the rhombus?



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

18. How many squares are exactly four greater than a prime?

A 0 B 1 C 2 D 3 E 4

19. What is the positive difference between the numerator and the denominator when the expression shown is written as a single fraction in its simplest form?

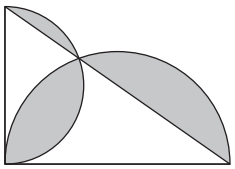
$$\frac{n}{n+1-\dfrac{n+2}{n+3}}$$

A $2n+2$ B $n+2$ C n D 2 E 1

20. I roll two standard six-sided fair dice. At least one of the scores obtained on the dice is 3. What is the probability that both of the scores on the dice are 3?

A $\frac{1}{12}$ B $\frac{1}{11}$ C $\frac{1}{6}$ D $\frac{1}{3}$ E $\frac{1}{4}$

21. A semicircle of radius 3 units is drawn on one edge of a right-angled triangle, and a semicircle of radius 4 units is drawn on another edge. The semicircles intersect on the hypotenuse of the triangle, as shown.
What is the shaded area, in square units?



A $\frac{25\pi}{2}-24$ B 12 C $\frac{25\pi}{2}-6$ D $25\pi-24$ E 24

22. The numbers x and y satisfy both of the equations

$$23x+977y=2023 \quad \text{and} \quad 977x+23y=2977.$$

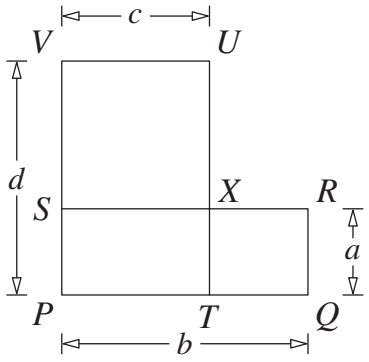
What is the value of x^2-y^2?

A 1 B 2 C 3 D 4 E 5

23. It is possible to choose, in two different ways, six different integers from 1 to 9 inclusive such that their product is a square. Let the two squares so obtained be p^2 and q^2, where p and q are both positive.
What is the value of $p+q$?

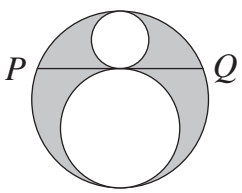
A 72 B 84 C 96 D 108 E 120

24. A rectangle $PQRS$ has side-lengths a and b, with $a<b$. The rectangle $PTUV$ has side-lengths c and d, with $c<d$. Also, $a<d$ and $c<b$, as shown. The sides RS and TU cross at X.
Which of these conditions guarantees that Q, X and V lie on a straight line?



A $\frac{a}{b}+\frac{c}{d}=1$ B $\frac{a}{c}+\frac{b}{d}=1$ C $\frac{a}{d}+\frac{c}{b}=1$
D $\frac{a}{c}+\frac{d}{b}=1$ E $\frac{c}{a}+\frac{b}{d}=1$

25. The diagram shows two unshaded circles which touch each other and also touch a larger circle. Chord PQ of the larger circle is a tangent to both unshaded circles. The length of PQ is 6 units.
What is the area, in square units, of the shaded region?



A 3π B $\frac{7\pi}{2}$ C 4π D $\frac{9\pi}{2}$ E 5π

1. How many hours is 6 minutes?

A 0.06 B 0.1 C 0.6 D 10 E 360

2. My recipe for apple crumble uses 100 g of flour, 50 g of butter and 50 g of sugar to make the crumble topping. When my family come for a meal, I have to use two and a half times each amount to provide enough crumble. In total, how much crumble topping do I then make?

A 0.5 kg B 2 kg C 2.5 kg D 5 kg E 50 kg

3. In the Caribbean, loggerhead turtles lay three million eggs in twenty thousand nests.
On average, how many eggs are in each nest?

A 15 B 150 C 1500 D 15 000 E 150 000

4. Workers digging a tunnel for an underground railway complete 5 metres of tunnel on a typical day.
Working every day, how long will it take them to dig a tunnel of length 2 kilometres?

A three months B six months C just under a year D just over a year
E nearly two years

5. Which of the following has the same value as $10\,006 - 8008$?

A $10\,007 - 8007$ B $100\,060 - 80\,080$ C $10\,000 - 8002$ D $106 - 88$
E $5003 - 4004$

6. What is 20% of $3\frac{3}{4}$?

A $\frac{123}{200}$ B $\frac{13}{20}$ C $\frac{7}{10}$ D $\frac{3}{4}$ E $\frac{4}{5}$

7. A function machine does the four operations shown in order.

Iris inputs a positive integer and the output is also a positive integer.
What is the smallest possible number which Iris could have input?

A 9 B 84 C 102 D 120 E 129

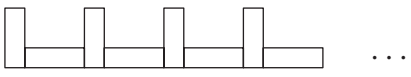
8. What is the difference between 40% of 50% of 60 and 50% of 60% of 70?

A 9 B 8 C 7 D 6 E 5

9. A number x is greater than 2022. Which is the smallest of the following?

A $\frac{x}{2022}$ B $\frac{2022}{x-1}$ C $\frac{x+1}{2022}$ D $\frac{2022}{x}$ E $\frac{2022}{x+1}$

10. One hundred rectangles are arranged edge-to-edge in a continuation of the pattern shown.



Each rectangle measures 3 cm by 1 cm. What is the perimeter, in cm, of the completed shape?

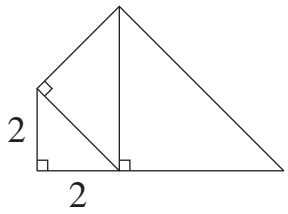
A 800 B 700 C 602 D 600 E 502

11. The Universal Magazine of Knowledge and Pleasure (Vol. 1, 1747) asked the following question.
"What number is that, whose quarter shall be 9 more than the whole?"
What is the correct answer?

A 12 B 9 C 8 D −8 E −12

12. The shape shown is made up of three similar right-angled triangles. The smallest triangle has two sides of side-length 2, as shown.

What is the area of the shape?

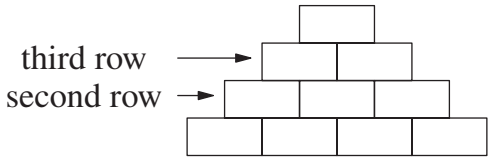


A 14 B $12+12\sqrt{2}$ C 28 D $24+20\sqrt{2}$ E 56

13. How many sets of three consecutive integers are there in which the sum of the three integers equals their product ?

A 0 B 2 C 3 D 4 E 5

14. In a number pyramid, each cell above the bottom row contains the sum of the numbers in the two cells immediately below it. The three numbers on the second row are all equal, and are all integers. Which of these statements *must* be true?



A The bottom row contains at least one zero
B The third row contains at least one zero
C The top number is a multiple of three
D The top number is a multiple of four
E None of the above

15. Reflection in the line l transforms the point with coordinates $(5, 3)$ into the point with coordinates $(1, -1)$.
What is the equation of the line l?

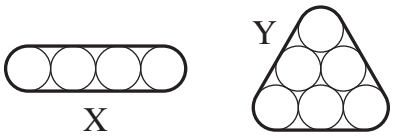
A $y = x - 2$ B $y = 1$ C $x = 3$ D $y = 2 - x$ E $y = 4 - x$

16. What is half of 4^{2022}?

A 4^{1011} B 2^{4044} C 4^{2021} D 2^{4043} E 2^{1011}

17. The first figure shows four touching circles of radius 1 cm in a horizontal row, held together tightly by an outer band X.

The second figure shows six touching circles of radius 1 cm, again held tightly together by a surrounding band Y.
Which of the following statements is true?

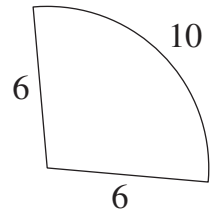


A X is 2 cm longer than Y
B X is 1 cm longer than Y
C X and Y are the same length
D Y is 1 cm longer than X
E Y is 2 cm longer than X

18. Dick Turnip sold his horse, Slack Bess, for £56. The percentage profit he made was numerically the same as the cost, in pounds, of his horse. What was the cost of his horse?

A £36 B £40 C £45 D £48 E £50

19. A sector of a circle has radius 6 and arc length 10, as shown.



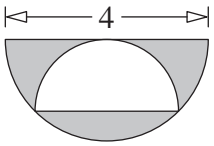
What is the area of the sector?

A 30 B 36 C 40 D 60 E 66

20. Aroon is asked to choose five integers so that the mode is 2 more than the median and the mean is 2 less than the median. What is the largest possible value of the range of Aroon's five integers?

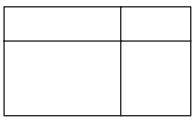
A 2 B 5 C 12 D 15
E The largest possible range depends on the integers chosen

21. The diagram shows a shaded semicircle of diameter 4, from which a smaller semicircle has been removed. The two semicircles touch at exactly three points. What fraction of the larger semicircle is shaded?



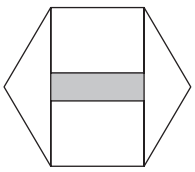
A $\frac{2}{\pi}$ B $\frac{1}{2}$ C $\frac{\sqrt{2}}{3}$ D $\frac{\sqrt{2}}{2}$ E $\frac{3}{4\pi}$

22. A rectangle with integer side-lengths is divided into four smaller rectangles, as shown. The perimeters of the largest and smallest of these smaller rectangles are 28 cm and 12 cm.
Which of the following is a possible area of the original rectangle?



A $90\,\text{cm}^2$ B $92\,\text{cm}^2$ C $94\,\text{cm}^2$ D $96\,\text{cm}^2$ E $98\,\text{cm}^2$

23. Two squares are drawn inside a regular hexagon with side-length 2, as shown. What is the area of the overlap of the two squares?



A 2 B $2-\sqrt{3}$ C $4-\sqrt{3}$ D $4-2\sqrt{3}$ E $8-4\sqrt{3}$

24. Pete's pies all cost an integer number of pounds. A cherry pie costs the same as two apple pies. A blueberry pie costs the same as two damson pies. A cherry pie and two damson pies cost the same as an apple pie and two blueberry pies. Paul buys one of each type of pie.
Which of the following could be the amount he spends?

A £16 B £18 C £20 D £22 E £24

25. Alvita is planning a garden patio to be made from identical square paving stones laid out in a rectangle measuring x stones by y stones. She finds that when she adds a border of width one stone around the patio, the area of the border is equal to the original area of the patio.
How many possible values for x are there?

A 1 B 2 C 4 D 8 E 16

1. What is the value of $2021 - 2223 + 2425$?

A 2122 B 2223 C 2324 D 2425 E 2526

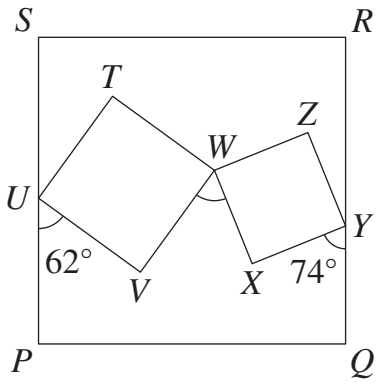
2. The day before the day before yesterday was two days after the day before my birthday. Today is Thursday. On what day was my birthday?

A Sunday B Monday C Tuesday D Wednesday E Friday

3. What is the value of $2 - (-2 - 2) - (-2 - (-2 - 2))$?

A 0 B 2 C 4 D 6 E 8

4. The diagram shows three squares, $PQRS$, $TUVW$ and $WXYZ$. Angles PUV and QYX are 62° and 74° respectively. What is angle VWX?



A 44° B 48° C 60° D 64° E 68°

5. April, May and June have 90 sweets between them. May has three-quarters of the number of sweets that June has. April has two-thirds of the number of sweets that May has. How many sweets does June have?

A 60 B 52 C 48 D 40 E 36

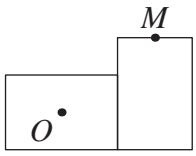
6. Kai has begun to list, in ascending order, the positive integers which are *not* factors of 240. What is the sixth number on Kai's list?

A 11 B 13 C 14 D 15 E 17

7. What is the value of $(4 - \frac{1}{4}) \div (2 - \frac{1}{2})$?

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

8. The diagram shows two 10 by 14 rectangles which are edge-to-edge and share a common vertex. It also shows the centre O of one rectangle and the midpoint M of one edge of the other. What is the distance OM?



A 12 B 15 C 18 D 21 E 24

9. How many of the following statements are true?

> A prime multiplied by a prime is always a prime.
> A square multiplied by a square is always a square.
> An odd number multiplied by an odd number is always an odd number.
> An even number multiplied by an even number is always an even number.

A 0 B 1 C 2 D 3 E 4

10. The prime factor decomposition of 2021 is 43×47.
What is the value of 53×57?

A 2221 B 2521 C 2921 D 3021 E 3031

11. The line with equation $y = 2x + 3$ is reflected in the x-axis.
Which of the following is the equation of the new line?

A $y = 2x - 3$ B $y = -2x + 3$ C $x = 2y + 3$ D $y = \frac{1}{2}x + 3$ E $y = -2x - 3$

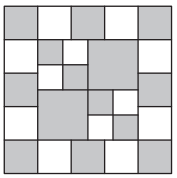
12. Andrew calculates that 40% of 50% of x is equal to 20% of 30% of y, where $x \neq 0$.
Which of the following is true?

A $y = \frac{2x}{3}$ B $y = \frac{4x}{3}$ C $y = 2x$ D $y = \frac{8x}{3}$ E $y = \frac{10x}{3}$

13. What is the remainder when $12\,345 \times 54\,321$ is divided by 9?

A 0 B 1 C 2 D 3 E 4

14. The diagram shows a large square divided into squares of three different sizes.
What percentage of the large square is shaded?

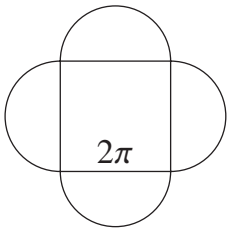


A 61% B 59% C 57% D 55% E 53%

15. Patrick drives from P to Q at an average speed of 40 mph. His drive back from Q to P is at an average speed of 45 mph and takes two minutes less.
How far, in miles, is it from P to Q?

A 1.5 B 6 C 9 D 12 E 15

16. A semicircle is drawn on each side of a square, as shown.
The square has sides of length 2π.
What is the area of the resulting shape?



A $2\pi^2(\pi + 1)$ B $\pi^2(\pi + 2)$ C $2\pi^2(2\pi + 1)$ D $\pi^2(\pi + 4)$
E $2\pi^2(\pi + 2)$

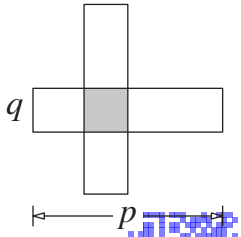
17. In the rectangle $PQRS$, the side PQ is of length 2 and the side QR is of length 4. Points T and U lie inside the rectangle so that PQT and RSU are equilateral triangles.
What is the area of the quadrilateral $QRUT$?

A $\frac{6 - \sqrt{3}}{2}$ B $\frac{8}{3}$ C $4 - 2\sqrt{3}$ D $4 - \sqrt{3}$ E 3

18. Which of these is closest in size to 1?

A $0.\dot{9}\dot{5}$ B $1.\dot{0}\dot{5}$ C $0.\dot{9}6\dot{0}$ D $1.\dot{0}4\dot{0}$ E $0.9\dot{5}$

19. The diagram shows two overlapping rectangles, each measuring p by q. The area of overlap is exactly one-quarter of the total area of the figure.
What is the ratio $p : q$?

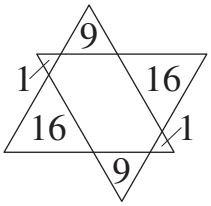


A 5 : 2 B 4 : 1 C 3 : 1 D 2 : 1 E 3 : 2

20. Two straight lines have equations $y = px + 4$ and $py = qx - 7$, where p and q are constants. The two lines meet at the point (3, 1).
What is the value of q?

A 1 B 2 C 3 D 4 E 5

21. The diagram shows two congruent equilateral triangles whose overlap is a hexagon. The areas of the smaller triangles, which are also equilateral, are 1, 1, 9, 9, 16 and 16, as shown.
What is the area of the inner hexagon?

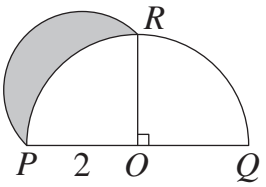


A 68 B 58 C 48 D 38 E 28

22. What is the result when we simplify the expression $\left(1+\frac{1}{x}\right)\left(1-\frac{2}{x+1}\right)\left(1+\frac{2}{x-1}\right)$?

A 1 B $\frac{1}{x(x+1)}$ C $\frac{1}{(x+1)(x-1)}$ D $\frac{1}{x(x+1)(x-1)}$ E $\frac{x+1}{x}$

23. The diagram shows a semicircle with centre O and radius 2 and a semicircular arc with diameter PR. Angle POR is a right angle.
What is the area of the shaded region?



A $\pi - 2$ B 2 C π D 3 E $2\pi - 2$

24. Sam writes on a white board the positive integers from 1 to 6 inclusive, once each. She then writes p additional fives and q sevens on the board. The mean of all the numbers on the board is then 5.3.
What is the smallest possible value of q?

A 7 B 9 C 11 D 13 E 15

25. Thomas has constant speeds for both running and walking. When a down-escalator is moving, Thomas can run down it in 15 seconds or walk down it in 30 seconds. One day, when the escalator was broken (and stationary), it took Thomas 20 seconds to run down it.
How long, in seconds, would it take Thomas to walk down the broken escalator?

A 30 B 40 C 45 D 50 E 60

1. What is the value of $2 - (3 - 4) - (5 - 6 - 7)$?

A 11 B 9 C 5 D -5 E -7

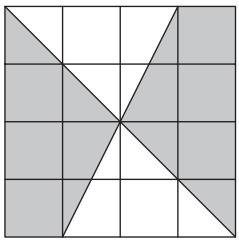
2. Which one of these is a multiple of 24?

A 200 B 300 C 400 D 500 E 600

3. What is the difference between 25% of £37 and 25% of £17?

A £4.25 B £5 C £6 D £7.50 E £9.25

4. What fraction of this diagram is shaded?



A $\frac{13}{32}$ B $\frac{1}{2}$ C $\frac{9}{16}$ D $\frac{5}{8}$ E $\frac{13}{16}$

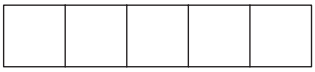
5. Four of the following coordinate pairs are the corners of a square.
Which is the odd one out?

A (4, 1) B (2, 4) C (5, 6) D (3, 5) E (7, 3)

6. Which of the following has the largest value?

A 2^6 B 3^5 C 4^4 D 5^3 E 6^2

7. Kartik wants to shade three of the squares in this grid blue and Lucy wants to shade the remaining two squares red. There are ten possible finished grids.
In how many of the finished grids are Lucy's red squares next to each other?



A 3 B 4 C 5 D 6 E 8

8. One of these options gives the value of $17^2 + 19^2 + 23^2 + 29^2$. Which is it?

A 2004 B 2008 C 2012 D 2016 E 2020

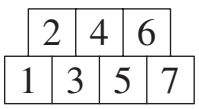
9. Adam's house number is in exactly one of the following ranges. Which one?

A 123 to 213 B 132 to 231 C 123 to 312 D 231 to 312 E 312 to 321

10. What is the value of $\dfrac{2468 \times 2468}{2468 + 2468}$?

A 2 B 1234 C 2468 D 4936 E 6 091 024

11. I start at square "1", and have to finish at square "7", moving at each step to a higher numbered adjacent square.
How many possible routes are there?



A 7 B 9 C 10 D 11 E 13

12. Farmer Fatima rears chickens and goats. Today she returned from market and said, "I sold 80 animals, and now there are 200 fewer legs on my farm than before!"
How many goats did she sell?

A 15 B 20 C 25 D 30 E 35

13. What is half of 1.6×10^6?

A 8×5^6 B 4×10^6 C 8×10^5 D 8×10^2 E 1.6×10^3

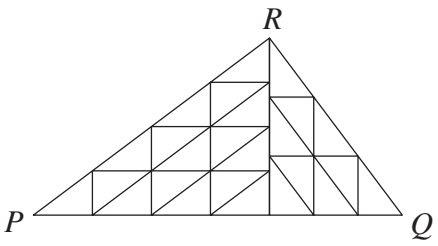
14. The result of the calculation $9 \times 11 \times 13 \times 15 \times 17$ is the six-digit number '$3n8185$'.
What is the value of n?

A 2 B 4 C 6 D 8 E 0

15. Triangle PQR has been divided into twenty-five congruent right-angled triangles, as shown. The length of RP is 2.4 cm.

What is the length of PQ?

A 3 cm B 3.2 cm C 3.6 cm D 4 cm
E 4.8 cm



16. As a decimal, what is the value of $\frac{1}{9} + \frac{1}{11}$?

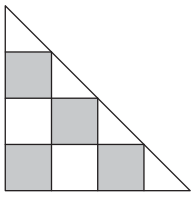
A 0.10 B 0.20 C 0.2020 D 0.202 020 E $0.\dot{2}\dot{0}$

17. The Knave of Hearts stole some tarts. He ate half of them, and half a tart more. The Knave of Diamonds ate half of what was left, and half a tart more. Then the Knave of Clubs ate half of what remained, and half a tart more. This left just one tart for the Knave of Spades.
How many tarts did the Knave of Hearts steal?

A 63 B 31 C 19 D 17 E 15

18. The diagram shows an isosceles right-angled triangle which has a hypotenuse of length y. The interior of the triangle is split up into identical squares and congruent isosceles right-angled triangles.
What is the total shaded area inside the triangle?

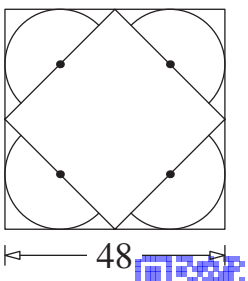
A $\frac{y^2}{2}$ B $\frac{y^2}{4}$ C $\frac{y^2}{8}$ D $\frac{y^2}{16}$ E $\frac{y^2}{32}$



19. The diagram shows two squares and four equal semicircles. The edges of the outer square have length 48 and the inner square joins the midpoints of the edges of the outer square. Each semicircle touches two edges of the outer square, and the diameter of each semicircle lies along an edge of the inner square.

What is the radius of each semicircle?

A 10 B 12 C 14 D 16 E 18

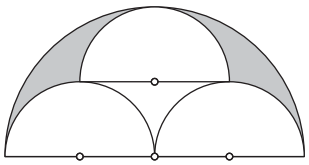


20. For any fixed value of x, which of the following four expressions has the largest value?

$(x+1)(x-1)$ $(x+\frac{1}{2})(x-\frac{1}{2})$ $(x+\frac{1}{3})(x-\frac{1}{3})$ $(x+\frac{1}{4})(x-\frac{1}{4})$

A $(x+1)(x-1)$ B $(x+\frac{1}{2})(x-\frac{1}{2})$ C $(x+\frac{1}{3})(x-\frac{1}{3})$ D $(x+\frac{1}{4})(x-\frac{1}{4})$
E it depends on the value of x

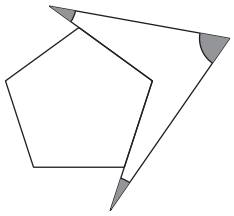
21. The diagram shows four semicircles, one with radius 2 cm, touching the other three, which have radius 1 cm.



What is the total area, in cm^2, of the shaded regions?

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

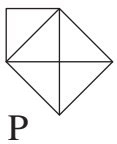
22. The diagram shows a regular pentagon and an irregular quadrilateral.

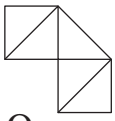


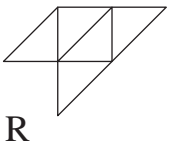
What is the sum of the three marked angles?

A 72° B 90° C 108° D 126° E 144°

23. Five congruent triangles, each of which is half a square, are placed together edge to edge in three different ways as shown to form shapes P, Q and R.


P


Q


R

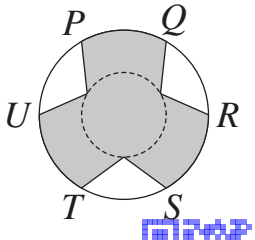
Which of the following lists gives the shapes in ascending order of the lengths of their perimeters?

A P, Q, R B Q, P, R C R, Q, P D R, P, Q E P, R, Q

24. The positive integers m and n are such that $10\times 2^m = 2^n + 2^{n+2}$.
What is the difference between m and n?

A 1 B 2 C 3 D 4 E 5

25. The diagram shows six points P, Q, R, S, T and U equally spaced around a circle of radius 2 cm. The inner circle has radius 1 cm. The shaded region has three lines of symmetry.
Which of the following gives the area, in cm^2, of the shaded region?



A $2\pi+3$ B $3\pi+2$ C $\dfrac{4\pi+3}{2}$ D $3(\pi+2)$ E $4\pi+3$

Senior Challenge

www.CasperYC.club

Last updated: October 10, 2025

Instructions

1. Do not open the paper until the invigilator tells you to do so.
2. Time allowed: **90 minutes**. No answers, or personal details, may be entered after the allowed time is over.
3. The use of blank 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, or 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**: All candidates start with 25 marks; 0 marks are awarded for each question left unanswered; 4 marks are awarded for each correct answer; 1 mark is deducted for each incorrect answer (to discourage guessing).
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, doodle, or leave bits of eraser stuck to the page, the machine will interpret the mark in its own way, or reject the answer sheet.
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.

Comments and suggestions to DrYuFromShanghai@QQ.com

Answers for UKMT Senior Challenges:

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
1	A	C	D	C	A	D	D	C	E	C	C	A	C	D	E	A	C	D	B	C	C	D	D	C	D	C	E	1
2	D	D	D	D	B	A	E	B	A	A	B	D	B	D	B	C	B	A	D	B	C	B	C	C	C	C	A	2
3	C	D	C	D	C	A	D	D	A	B	D	E	C	B	D	D	D	B	B	E	D	A	A	C	C	D	B	3
4	B	C	E	A	C	C	D	A	C	C	C	E	B	D	B	C	A	B	C	E	E	B	B	D	D	C	C	4
5	C	B	A	D	E	A	B	E	A	E	E	A	D	B	C	E	C	A	A	C	B	B	C	E	C	B	B	5
6	E	B	D	C	C	B	E	B	D	A	E	C	B	C	C	E	B	E	D	B	B	D	E	B	E	B	D	6
7	D	D	D	E	B	C	C	E	B	D	D	B	C	D	D	B	B	B	A	C	A	D	D	B	C	D	A	7
8	D	B	B	B	D	E	C	D	C	E	A	C	D	C	C	B	C	D	B	B	B	B	D	B	E	A	D	8
9	D	C	B	B	A	B	D	C	C	E	D	D	D	B	C	A	D	B	C	B	A	D	B	D	B	D	E	9
10	C	D	C	E	E	D	B	B	B	B	D	B	E	C	E	B	C	D	B	D	D	C	C	D	D	B	D	10
11	B	E	A	A	A	C	A	A	E	D	B	C	D	C	D	A	E	C	E	D	B	C	E	E	A	B	D	11
12	B	E	B	B	A	C	C	D	E	E	C	E	A	D	E	B	D	A	C	B	A	E	B	A	E	E	A	12
13	D	C	B	D	D	A	A	D	D	B	C	C	A	D	B	D	E	E	A	C	E	D	D	D	C	A	C	13
14	E	A	E	A	E	E	C	C	B	B	D	D	E	C	D	D	E	E	D	A	D	C	B	D	A	E	B	14
15	B	E	A	A	D	D	C	E	C	D	A	D	E	B	A	B	C	C	B	B	D	B	A	C	B	D	C	15
16	D	D	C	B	E	A	E	B	C	A	A	B	E	E	A	D	A	A	D	D	D	A	E	C	B	A	B	16
17	A	C	D	C	D	C	A	E	E	C	E	C	E	A	B	A	C	C	D	D	B	E	A	B	B	E	E	17
18	D	A	E	E	B	E	A	A	D	A	C	A	A	E	A	C	D	D	E	E	A	E	E	C	B	C	C	18
19	B	C	A	C	C	E	B	A	C	D	B	C	B	B	E	C	E	A	D	B	C	A	A	D	E	E	C	19
20	A	E	E	C	A	B	E	C	D	C	B	E	C	B	E	E	A	E	E	B	E	A	E	A	D	C	D	20
21	C	A	A	C	D	B	B	E	B	B	B	B	A	C	D	B	B	C	C	C	A	D	C	A	D	D	B	21
22	D	E	B	E	B	C	B	C	A	D	A	C	B	A	B	C	A	B	C	D	C	C	A	E	B	C	A	22
23	E	B	C	A	E	B	D	B	D	E	B	D	B	B	C	A	E	D	E	C	B	B	D	A	A	D	E	23
24	A	A	E	E	B	A	E	D	A	D	E	B	E	B	B	E	A	C	B	D	E	E	B	E	D	B	E	24
25	E	B	C	D	C	D	C	A	E	D	D	A	D	C	B	D	B	C	D	A	C	A	C	B	A	A	A	25
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	

Comments and suggestions to DrYuFromShanghai@QQ.com

1. What is two-fifths of the recurring decimal $0.\dot{2}\dot{5}$?

A $0.\dot{1}$ B $0.0\dot{1}$ C $0.\dot{0}\dot{1}$ D 0.10 E $0.\dot{1}\dot{0}$

2. A ***twip*** is a very short unit of length, derived from imperial units, and is equal to approximately 0.000018 metres. A ***league*** is a long unit of length which is equal to approximately 4800 metres.

Roughly how many twips are there in a league?

A 270 000 000 B 27 000 000 C 2 700 000 D 270 000 E 27 000

3. Two standard dice are placed on a table, with one on top of the other, so that only nine of the faces of the dice may be seen. The touching faces have the same number on them. The sum of the numbers on the visible faces is 33.

What is the number on the touching faces?

A 1 B 2 C 3 D 4 E 6

4. The sizes of the three angles in a triangle, in degrees, are x, $7x$ and x^2.

What is the size of the largest angle?

A $10°$ B $18°$ C $100°$ D $120°$ E $121°$

5. When $4^5 \times 5^4$ is correctly calculated, how many digits are there in the answer?

A 4 B 6 C 10 D 16 E 20

6. One face of a solid polyhedron is an octagon.

What is the smallest possible number of edges the solid could have?

A 9 B 10 C 12 D 16 E 24

7. Which is the largest prime factor of $3^8 - 1$?

A 41 B 37 C 31 D 29 E 23

8. In the following expressions, x is non-zero. When one of these expressions is removed, the mean of the remaining four is $11x$.

Which expression is removed?

A $4x$ B $8x$ C $12x$ D $16x$ E $20x$

9. A palindromic number is one where the digits read the same forwards as backwards, such as 123 321.

What is the hundreds digit of the largest six-digit palindromic number that is divisible by 18?

A 9 B 7 C 5 D 3 E 1

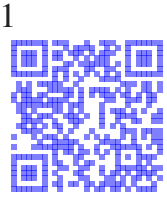
10. The prime factorization of 2024 is $2^3 \times 11 \times 23$.

How many two-digit numbers are factors of 2024?

A 2 B 4 C 6 D 7 E 8

11. Which one of the following expressions is a square number for each positive integer n?

A $n+1$ B $n(n+1)+1$ C $n(n+1)(n+2)+1$
D $n(n+1)(n+2)(n+3)+1$ E $n(n+1)(n+2)(n+3)(n+4)+1$

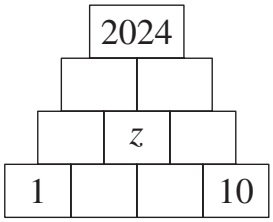


12. p, q, r and s are two-digit primes which between them use all the non-zero digits except 5.

What is the value of $p+q+r+s$?

A 220 B 210 C 200 D 190
E more information needed

13. The diagram shows a partially completed number pyramid. When correctly completed, the number on any brick above the bottom row should be the sum of the two numbers on the two bricks on which it rests.



What number should appear on the brick marked 'z'?

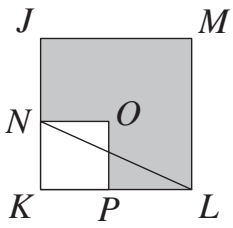
A 176 B 617 C 671 D 716 E 761

14. P, Q, R, S and T are the digits 1, 2, 3, 4 and 5 in some order. 'PRT' and 'QRS' are both three-digit primes.

Which digit is R?

A 1 B 2 C 3 D 4 E 5

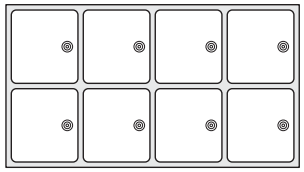
15. The diagram shows two squares, $JKLM$ and $NKPO$.
The length of NL is 10 cm. The shaded region has area 62 cm^2.



What is the length of KN in cm?

A 3 B $\sqrt{18}$ C $\sqrt{19}$ D $\sqrt{22}$ E 5

16. A set of cupboards containing eight identical blue doors is arranged in a 2 by 4 grid as shown. A fussy decorator wishes to paint three of the doors red such that at least one door in each row is painted red and at least two of the four corners are painted red.



How many ways are there to do this?

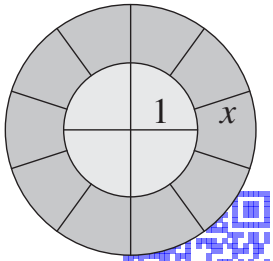
A 12 B 24 C 36 D 40 E 56

17. A bag contains four balls each of which is coloured either red or white. If one ball is drawn at random from the bag but not replaced and then a second ball is drawn at random, the probability that both balls are red is $\frac{1}{2}$.

What is the probability that both balls are white?

A $\frac{1}{2}$ B $\frac{1}{3}$ C $\frac{1}{4}$ D $\frac{1}{6}$ E 0

18. The diagram shows two concentric circles divided by radial lines into 14 pieces of equal area. The radius of the smaller circle is 1.



What is the length, x, of an outer radial line?

A $\sqrt{14}-1$ B $\sqrt{14}-2$ C $\frac{\sqrt{14}}{2}-1$ D $\frac{\sqrt{14}}{2}-2$ E $\frac{\sqrt{14}-1}{2}$

19. Five friends are dealt two cards each from a set of twelve cards. The cards are numbered 1 to 12 inclusive. In turn, the friends declare the sum of the values of their two cards. Paolo scores 4, Quinn scores 11, Romy scores 16, Stephen scores 19 and Thomas scores 20.

Which of the following statements is true?

A Paolo has card 2 B Quinn has card 3 C Romy has card 5 D Stephen has card 7
E Thomas has card 11

20. Let x and y be positive integers such that $\frac{1}{x}+\frac{1}{y}=\frac{1}{20}$. What is the maximum possible value of y?

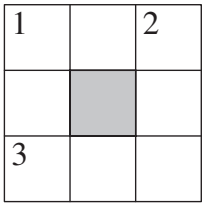
A 40 B 60 C 240 D 420 E 480

21. The crossnumber is to be filled with eight of the digits 1 to 9, which are each used once.

Which digit is not used?

Across
1. A multiple of 9
3. A square

Down
1. A multiple of 11
2. A multiple of 13 and of 19

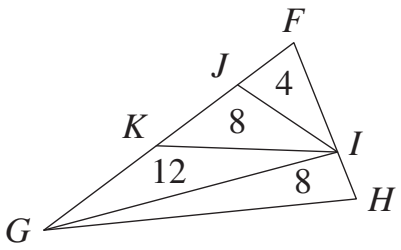


A 9 B 8 C 5 D 3 E 2

22. As shown in the diagram, triangle FGH is divided into four smaller triangles which have areas 4, 8, 12 and 8 respectively.

What is the area of triangle IKH?

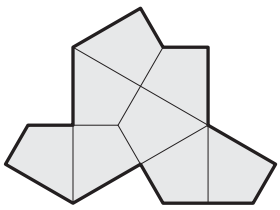
A 4 B 5 C 6 D 7 E 8



23. The plane can be tiled using the 'hat tile' shown here. This tile can be subdivided into eight congruent kites. The area of the hat tile is $8\sqrt{3}$.

What is the perimeter of the hat tile?

A $8+12\sqrt{3}$ B $16+6\sqrt{3}$ C $8+8\sqrt{3}$ D $6+8\sqrt{3}$
E $8+6\sqrt{3}$



24. A function f satisfies the equation $f(x)+f\left(\frac{1}{1-x}\right)=24x$ for all real values of x except $x=0$ and $x=1$.

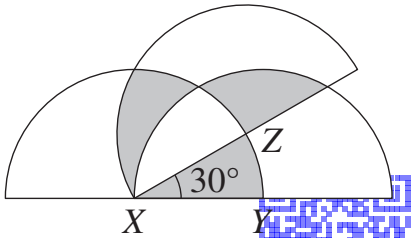
What is the value of $f(3)$?

A 40 B 42 C 45 D 48 E 50

25. Three semicircles, each of area 24, overlap as shown in the diagram. The centres of the arcs are X, Y and Z and $\angle ZXY=30°$.

What is the total area of the shaded regions?

A 12 B $6\sqrt{3}$ C 15 D 18 E $8\sqrt{3}$



1. What is the value of $\sqrt{\dfrac{2023}{2+0+2+3}}$?

A 13 B 15 C 17 D 19 E 21

2. What is the difference between one-third and 0.333?

A 0 B $\dfrac{3}{1000}$ C $\dfrac{1}{3000}$ D $\dfrac{3}{10000}$ E $\dfrac{1}{30000}$

3. The base of a triangle is increased by 20% and its height is decreased by 15%.

What happens to its area?

A It decreases by 3% B It remains the same C It decreases by 2%
D It increases by 2% E It increases by 5%

4. In 2016, the world record for completing a 5000m three-legged race was 19 minutes and 6 seconds. It was set by Damian Thacker and Luke Symonds in Sheffield.

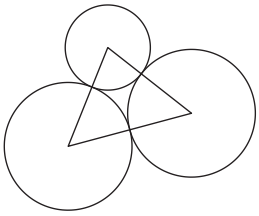
What was their approximate average speed in km/h?

A 10 B 12 C 15 D 18 E 25

5. Three circles with radii 2, 3 and 3 touch each other, as shown in the diagram.

What is the area of the triangle formed by joining the centres of these circles?

A 10 B 12 C 14 D 16 E 18



6. How many lines of three adjacent cells can be chosen from this grid, horizontally, vertically or diagonally, such that the sum of the numbers in the three cells is a multiple of three?

A 30 B 24 C 18 D 12 E 6

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

7. A sequence begins 2023, 2022, 1, ... After the first two terms, each term is the positive difference between the previous two terms.

What is the value of the 25th term?

A 2010 B 2009 C 2008 D 2007 E 2006

8. What is the value of $99(0.\dot{4}\dot{9} - 0.\dot{4})$?

A 5 B 4 C 3 D 2 E 1

9. When completed correctly, the cross number is filled with four three-digit numbers.

What digit is *?

A 0 B 1 C 2
D 4 E 6

Across
1. A square
3. A fourth power

Down
1. Twice a fifth power
2. A cube

1	*	2
3		

10. How many of the numbers 6, 7, 8, 9, 10 are factors of the sum $2^{2024} + 2^{2023} + 2^{2022}$?

A 1 B 2 C 3 D 4 E 5

11. Wenlu, Xander, Yasser and Zoe make the following statements:

Wenlu: "Xander is lying." Xander: " Yasser is lying."

Yasser: "Zoe is telling the truth." Zoe: "Wenlu is telling the truth."

What are the possible numbers of people telling the truth?

A 1 or 2 B 1 or 3 C 2 D 2 or 3 E 3

12. The greatest power of 7 which is a factor of 50! is 7^k $(n! = 1 \times 2 \times 3 \times 4 \times \ldots \times (n-1) \times n)$.

What is k?

A 4 B 5 C 6 D 7 E 8

13. $PQRST$ is a regular pentagon. The point U lies on ST such that $\angle QPU$ is a right angle.

What is the ratio of the interior angles in triangle PUT?

A 1 : 3 : 6 B 1 : 2 : 4 C 2 : 3 : 4 D 1 : 4 : 8 E 1 : 3 : 5

14. The points $P\ (d, -d)$ and $Q\ (12 - d, 2d - 6)$ both lie on the circumference of the same circle whose centre is the origin.

What is the sum of the two possible values of d?

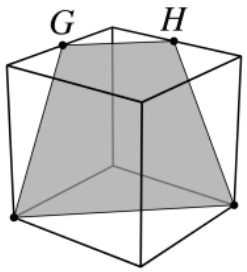
A -16 B -4 C 4 D 8 E 16

15. In Bethany's class of 30 students, twice as many people played basketball as played football. Twice as many played football as played neither.

Which of the following options could have been the number of people who played both?

A 19 B 14 C 9 D 5 E 0

16. G and H are midpoints of two adjacent edges of a cube. A trapezium-shaped cross-section is formed cutting through G, H and two further vertices, as shown. The edge-length of the cube is $2\sqrt{2}$.



What is the area of the trapezium?

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

17. The number $M = 124563987$ is the smallest number which uses all the non-zero digits once each and which has the property that none of the pairs of its consecutive digits makes a prime number. For example, the 5th and 6th digits of M make the number 63 which is not prime. N is the largest number which uses all the non-zero digits once each and which has the property that none of the pairs of its consecutive digits makes a prime number.

What are the 5th and 6th digits of N?

A 6 and 3 B 5 and 4 C 5 and 2 D 4 and 8 E 3 and 5

18. How many solutions are there of the equation $1+2\sin X-4\sin^2 X-8\sin^3 X=0$ with $0^\circ < X < 360^\circ$?

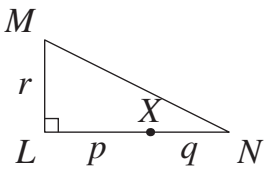
A 1 B 2 C 4 D 6 E 8

19. The expression $\dfrac{7n+12}{2n+3}$ takes integer values for certain integer values of n.

What is the sum of all such integer values of the expression?

A 4 B 8 C 10 D 12 E 14

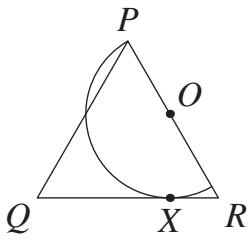
20. Triangle LMN represents a right-angled field with $LM = r$, $LX = p$ and $XN = q$. Jenny and Vicky walk at the same speed in opposite directions along the edge of the field, starting at X at the same time. Their first meeting is at M.



Which of these expressions gives q in terms of p and r?

A $\dfrac{p}{2}+r$ B $\sqrt{p^2+r^2}+\dfrac{p}{2}$ C $\dfrac{pr}{2p+r}$ D $\dfrac{p}{2}$ E 1

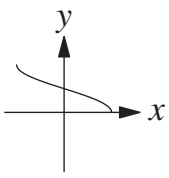
21. Triangle PQR is equilateral. A semicircle with centre O is drawn with its diameter on PR so that one end is at P and the curved edge touches QR at X. The radius of the semicircle is $\sqrt{3}$.

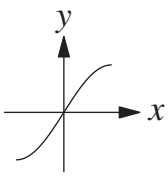


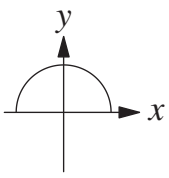
What is the length of QX?

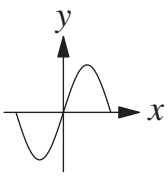
A $\sqrt{3}$ B $2-\sqrt{3}$ C $2\sqrt{3}-1$ D $1+\sqrt{3}$ E $2\sqrt{3}$

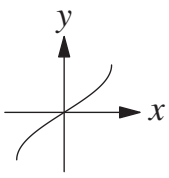
22. Which diagram could be a sketch of the curve $y=\sin(\cos^{-1}x)$?

A 

B 

C 

D 

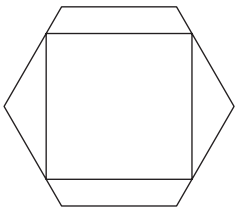
E 

23. The length of a rectangular piece of paper is three times its width. The paper is folded so that one vertex lies on top of the opposite vertex, thus forming a pentagonal shape.

What is the area of the pentagon as a fraction of the area of the original rectangle?

A $\dfrac{2}{3}$ B $\dfrac{11}{16}$ C $\dfrac{12}{17}$ D $\dfrac{13}{18}$ E $\dfrac{14}{19}$

24. A square has its vertices on the edges of a regular hexagon. Two of the edges of the square are parallel to two edges of the hexagon, as shown in the diagram. The sides of the hexagon have length 1.



What is the length of the sides of the square?

A $\dfrac{5}{4}$ B $3-\sqrt{3}$ C $\dfrac{4}{3}$ D $\sqrt{2}$ E $\dfrac{3}{2}$

25. What is the area of the part of the xy-plane within which $x^3y^2-x^2y^2-xy^4+xy^3 \geq 0$ and $0 \leq x \leq y$?

A $\dfrac{1}{4}$ B $\dfrac{1}{2}$ C 1 D 2 E 4

1. When the expression $\dfrac{(2^2-1)\times(3^2-1)\times(4^2-1)\times(5^2-1)}{(2\times3)\times(3\times4)\times(4\times5)\times(5\times6)}$ is simplified, which of the following is obtained?

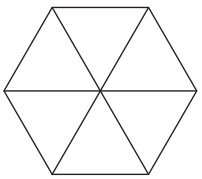
A $\frac{1}{2}$ B $\frac{1}{3}$ C $\frac{1}{4}$ D $\frac{1}{5}$ E $\frac{1}{6}$

2. What is the smallest prime which is the sum of five different primes?

A 39 B 41 C 43 D 47 E 53

3. The figure shows a regular hexagon.

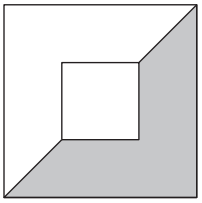
How many parallelograms are there in the figure?



A 2 B 4 C 6 D 8
E more than 8

4. The diagram shows two symmetrically placed squares with sides of length 2 and 5.

What is the ratio of the area of the small square to that of the shaded region?



A 7 : 24 B 1 : 3 C 8 : 25 D 8 : 21 E 2 : 5

5. What is the value of $\dfrac{1}{1.01}+\dfrac{1}{1.1}+\dfrac{1}{1}+\dfrac{1}{11}+\dfrac{1}{101}$?

A 2.9 B 2.99 C 3 D 3.01 E 3.1

6. What is the value of $\dfrac{4^{800}}{8^{400}}$?

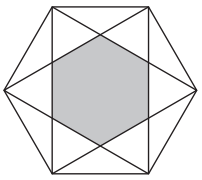
A $\frac{1}{2^{400}}$ B $\frac{1}{2^{200}}$ C 1 D 2^{200} E 2^{400}

7. In 2021, a first class postage stamp cost 85p and a second class postage stamp cost 66p. In order to spend an exact number of pounds and to buy at least one of each type, what is the smallest total number of stamps that should be purchased?

A 10 B 8 C 7 D 5 E 2

8. In the diagram, the outer hexagon is regular and has an area of 216.

What is the shaded area?



A 108 B 96 C 90 D 84 E 72

9. A light-nanosecond is the distance that a photon can travel at the speed of light in one billionth of a second. The speed of light is $3\times10^8\,\mathrm{ms}^{-1}$.

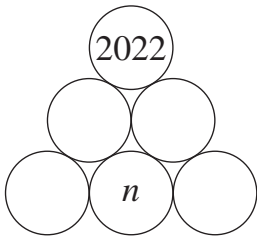
How far is a light-nanosecond?

A 3 cm B 30 cm C 3 m D 30 m E 300 m

10. What is the value of x in the equation $\dfrac{1+2x+3x^2}{3+2x+x^2}=3$?

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

11. In the number triangle shown, each disc is to be filled with a positive integer. Each disc in the top or middle row contains the number which is the product of the two numbers immediately below.



What is the value of n?

A 1 B 2 C 3 D 6 E 33

12. What is the sum of the digits of the integer which is equal to $6666666^2 - 3333333^2$?

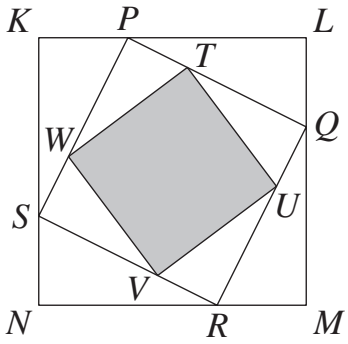
A 27 B 36 C 45 D 54 E 63

13. Three rugs have a combined area of $90\,\text{m}^2$. When they are laid down to cover completely a floor of area $60\,\text{m}^2$, the area which is covered by exactly two layers of rug is $12\,\text{m}^2$.

What is the area of floor covered by exactly three layers of rug?

A $2\,\text{m}^2$ B $6\,\text{m}^2$ C $9\,\text{m}^2$ D $10\,\text{m}^2$ E $12\,\text{m}^2$

14. The diagram shows a square, $KLMN$. A second square $PQRS$ is drawn inside it, as shown in the diagram, where P divides the side KL in the ratio $1 : 2$. Similarly, a third square $TUVW$ is drawn inside $PQRS$ with T dividing PQ in the ratio $1 : 2$.



What fraction of the area of $KLMN$ is shaded?

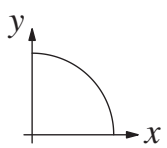
A $\frac{25}{81}$ B $\frac{16}{49}$ C $\frac{4}{9}$ D $\frac{40}{81}$ E $\frac{2}{3}$

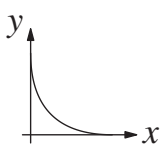
15. The hare and the tortoise had a race over 100 m, in which both maintained constant speeds. When the hare reached the finish line, it was 75 m in front of the tortoise. The hare immediately turned around and ran back towards the start line.

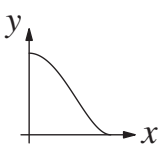
How far from the finish line did the hare and the tortoise meet?

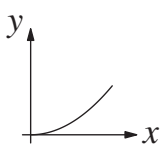
A 54 B 60 C 64 D $66\frac{2}{3}$ E 72

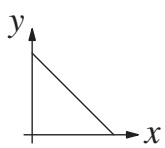
16. Which diagram could be a sketch of the curve $\sqrt{x} + \sqrt{y} = 1$?

A 

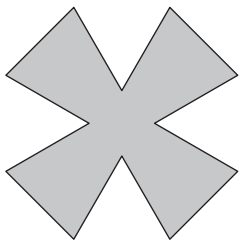
B 

C 

D 

E 

17. The shape shown is made by removing four equilateral triangles with side-length 1 from a regular octagon with side-length 1.



What is the area of the shape?

A $2 - 2\sqrt{2} + \sqrt{3}$ B $2 + 2\sqrt{2} - \sqrt{3}$ C $2 + 2\sqrt{2} + \sqrt{3}$
D $3 - 2\sqrt{2} - \sqrt{3}$ E $2 - 2\sqrt{2} - \sqrt{3}$

18. The numbers x and y are such that $3^x + 3^{y+1} = 5\sqrt{3}$ and $3^{x+1} + 3^y = 3\sqrt{3}$.

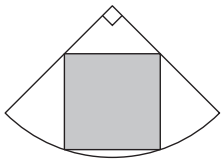
What is the value of $3^x + 3^y$?

A $\sqrt{3}$ B $2\sqrt{3}$ C $3\sqrt{3}$ D $4\sqrt{3}$ E $5\sqrt{3}$

19. How many pairs of real numbers (x, y) satisfy the simultaneous equations $x^2 - y = 2022$ and $y^2 - x = 2022$?

A infinitely many B 1 C 2 D 3
E 4

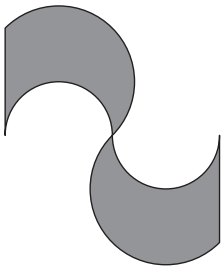
20. A square is inscribed inside a quadrant of a circle. The circle has radius 10.



What is the area of the square?

A $25\sqrt{2}$ B 36 C 12π D 40 E $30\sqrt{2}$

21. The perimeter of a logo is created from two vertical straight edges, two small semicircles with horizontal diameters and two large semicircles. Both of the straight edges and the diameters of the small semicircles have length 2. The logo has rotational symmetry as shown.



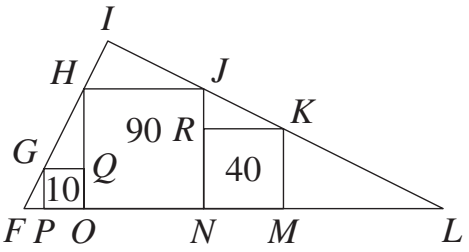
What is the shaded area?

A 4 B $4 - \pi$ C 8 D $4 + \pi$ E 12

22. How many pairs of integers (x, y) satisfy the equation $\sqrt{x - \sqrt{x + 23}} = 2\sqrt{2} - y$?

A 0 B 1 C 4 D 8
E infinitely many

23. Three squares $GQOP$, $HJNO$ and $RKMN$ have vertices which sit on the sides of triangle FIL as shown. The squares have areas of 10, 90 and 40 respectively.



What is the area of triangle FIL?

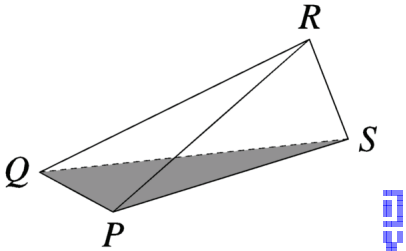
A 220.5 B $\frac{21}{5}\sqrt{10}$ C 252 D $\frac{21}{2}\sqrt{10}$
E 441

24. The numbers x, y, p and q are all integers. x and y are variable and p and q are constant and positive. The four integers are related by the equation $xy = px + qy$.

When y takes its maximum possible value, which expression is equal to $y - x$?

A $pq - 1$ B $(p - 1)(q - 1)$ C $(p + 1)(q - 1)$ D $(p - 1)(q + 1)$
E $(p + 1)(q + 1)$

25. A drinks carton is formed by arranging four congruent triangles as shown. $QP = RS = 4$ cm and $PR = PS = QR = QS = 10$ cm.



What is the volume, in cm^3, of the carton?

A $\frac{16}{3}\sqrt{23}$ B $\frac{4}{3}\sqrt{2}$ C $\frac{128}{25}\sqrt{6}$ D $\frac{13}{2}\sqrt{23}$ E $\frac{8}{3}\sqrt{6}$

1. Cicely had her 21st birthday in 1939.

When did she have her 100th birthday?

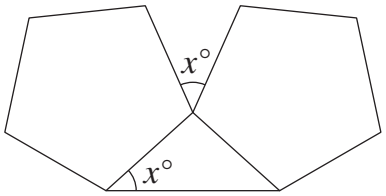
A 2020 B 2019 C 2018 D 2010 E 2008

2. The sequence, formed from the sequence of primes by rounding each to the nearest ten, begins 0, 0, 10, 10, 10, 10, 20, 20, 20, 30, ...

When continued, how many terms in this sequence are equal to 40?

A 1 B 2 C 3 D 4 E 5

3. The diagram shows two congruent regular pentagons and a triangle. The angles marked $x°$ are equal.



What is the value of x?

A 24 B 30 C 36 D 40 E 45

4. The positive integer k is a solution of the equation $(k \div 12) \div (15 \div k) = 20$.

What is the sum of the digits of k?

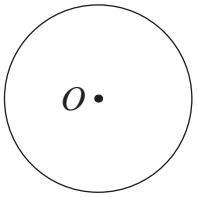
A 15 B 12 C 9 D 6 E 3

5. The sum of four consecutive primes is itself prime.

What is the largest of the four primes?

A 37 B 29 C 19 D 13 E 7

6. Three points, P, Q and R are placed on the circumference of a circle with centre O. The arc lengths PQ, QR and RP are in the ratio 1 : 2 : 3.



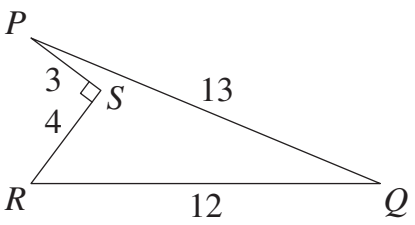
In what ratio are the areas of the sectors POQ, QOR and ROP?

A 1 : 1 : 1 B 1 : 2 : 3 C $1 : \pi : \pi^2$ D 1 : 4 : 9
E 1 : 8 : 27

7. Which of these numbers is the largest?

A 2^{5000} B 3^{4000} C 4^{3000} D 5^{2000} E 6^{1000}

8. What is the area of the region inside the quadrilateral $PQRS$?



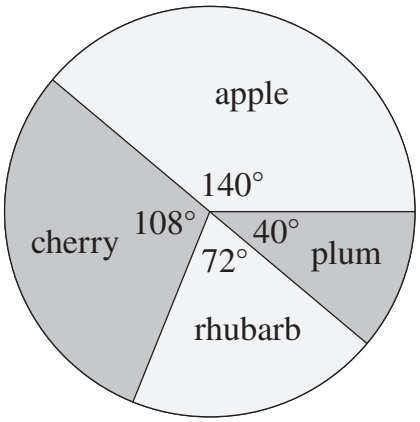
A 18 B 24 C 36 D 48
E more information needed

9. Alison has a set of ten fridge magnets showing the integers from 0 to 9 inclusive.

In how many different ways can she split the set into five pairs so that the sum of each pair is a multiple of 5?

A 1 B 2 C 3 D 4 E 5

10. In a survey, people were asked to name their favourite fruit pie. The pie chart shows the outcome. The angles shown are exact with no rounding.



What is the smallest number of people who could have been surveyed?

A 45 B 60 C 80 D 90 E 180

11. Alitta claims that if p is an odd prime then $p^2 - 2$ is also an odd prime.

Which of the following values of p is a counterexample to this claim?

A 3 B 5 C 7 D 9 E 11

12. For how many positive integers N is the remainder 6 when 111 is divided by N?

A 5 B 4 C 3 D 2 E 1

13. Which of these is the mean of the other four?

A $\sqrt{2}$ B $\sqrt{18}$ C $\sqrt{200}$ D $\sqrt{32}$ E $\sqrt{8}$

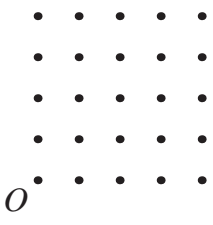
14. What is the smallest number of rectangles, each measuring 2 cm by 3 cm, which are needed to fit together without overlap to form a rectangle whose sides are in the ratio 5 : 4 ?

A 10 B 15 C 20 D 30 E 60

15. Three dice, each showing numbers 1 to 6, are coloured red, blue and yellow respectively. Each of the dice is rolled once. The total of the numbers rolled is 10. In how many different ways can this happen?

A 36 B 30 C 27 D 24 E 21

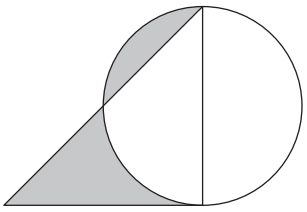
16. An array of 25 equally spaced dots is drawn in a square grid as shown. Point O is in the bottom left corner. Linda wants to draw a straight line through the diagram which passes through O and exactly one other point.



How many such lines can Linda draw?

A 4 B 6 C 8 D 12 E 24

17. A circle of radius r and a right-angled isosceles triangle are drawn such that one of the shorter sides of the triangle is a diameter of the circle.



What is the shaded area?

A $\sqrt{2}r$ B r^2 C $2\pi r$ D $\frac{\pi r^2}{4}$

E $(\sqrt{2}-1)\pi r^2$

18. The number 840 can be written as $\frac{p!}{q!}$, where p and q are positive integers less than 10.

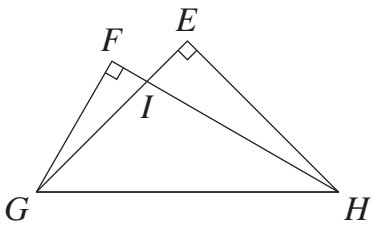
What is the value of $p+q$?

Note that, $n! = 1 \times 2 \times 3 \times \cdots \times (n-1) \times n$.

A 8 B 9 C 10 D 12 E 15

19. The diagram shows two overlapping triangles: triangle FGH with interior angles 60°, 30° and 90° and triangle EGH which is a right-angled isosceles triangle.

What is the ratio of the area of triangle IFG to the area of triangle IEH?



A 1 : 1 B 1 : $\sqrt{2}$ C 1 : $\sqrt{3}$ D 1 : 2 E 1 : 3

20. Laura and Dina have a running race. Laura runs at constant speed and Dina runs n times as fast where $n > 1$. Laura starts s m in front of Dina.

What distance, in metres, does Dina run before she overtakes Laura?

A $\frac{ns}{n-1}$ B ns C $\frac{s}{n-1}$ D $\frac{ns}{n+1}$ E $\frac{s}{n}$

21. The numbers m and k satisfy the equations $2^m + 2^k = p$ and $2^m - 2^k = q$.

What is the value of 2^{m+k} in terms of p and q?

A $\frac{p^2-q^2}{4}$ B $\frac{pq}{2}$ C $p+q$ D $\frac{(p-q)^2}{4}$ E $\frac{p+q}{p-q}$

22. A triangle with interior angles 60°, 45° and 75° is inscribed in a circle of radius 2.

What is the area of the triangle?

A $2\sqrt{3}$ B 4 C $6+\sqrt{3}$ D $6\sqrt{3}$ E $3+\sqrt{3}$

23. Let x be a real number. What is the minimum value of $(x^2-4x+3)(x^2+4x+3)$?

A -16 B -9 C 0 D 9 E 16

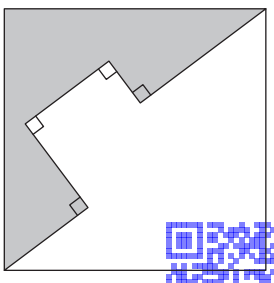
24. Saba, Rayan and Derin are cooperating to complete a task. They each work at a constant rate independent of whoever else is working on the task. When all three work together, it takes 5 minutes to complete the task. When Saba is working with Derin, the task takes 7 minutes to complete. When Rayan is working with Derin, the task takes 15 minutes to complete.

How many minutes does it take for Derin to complete the task on his own?

A 21 B 28 C 35 D 48 E 105

25. Five line segments of length 2, 2, 2, 1 and 3 connect two corners of a square as shown in the diagram.

What is the shaded area?



A 8 B 9 C 10 D 11 E 12

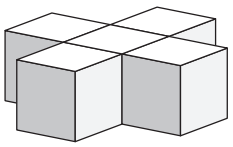
1. What is the value of $\dfrac{2020}{20 \times 20}$?

A 10.1 B 5.5 C 5.1 D 5.05 E 0.55

2. What is the remainder when 1234×5678 is divided by 5?

A 0 B 1 C 2 D 3 E 4

3. A shape is made from five unit cubes, as shown.



What is the surface area of the shape?

A 22 B 24 C 26 D 28 E 30

4. The numbers p, q, r and s satisfy the equations $p = 2$, $p \times q = 20$, $p \times q \times r = 202$ and $p \times q \times r \times s = 2020$.

What is the value of $p + q + r + s$?

A 32 B 32.1 C 33 D 33.1 E 34

5. What is $\sqrt{123454321}$?

A 1111111 B 111111 C 11111 D 1111 E 111

6. There are fewer than 30 students in the A-level mathematics class. One half of them play the piano, one quarter play hockey and one seventh are in the school play.

How many of the students play hockey?

A 3 B 4 C 5 D 6 E 7

7. Official UK accident statistics showed that there were 225 accidents involving teapots in one year. However, in the following year there were 47 such accidents.

What was the approximate percentage reduction in recorded accidents involving teapots from the first year to the second?

A 50% B 60% C 70% D 80% E 90%

8. What is the largest prime factor of $106^2 - 15^2$?

A 3 B 7 C 11 D 13 E 17

9. In 2018, a racing driver was allowed to use the Drag Reduction System provided that the car was within 1 second of the car ahead. Suppose that two cars were 1 second apart, each travelling at 180 km/h (in the same direction!).

How many metres apart were they?

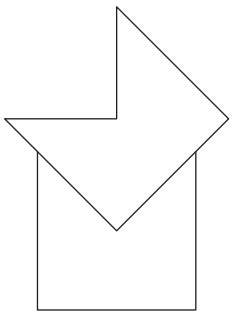
A 100 B 50 C 10 D 5 E 1

10. Six friends Pat, Qasim, Roman, Sam, Tara and Uma, stand in a line for a photograph. There are three people standing between Pat and Qasim, two between Qasim and Roman and one between Roman and Sam. Sam is not at either end of the line.

How many people are standing between Tara and Uma?

A 4 B 3 C 2 D 1 E 0

11. Two congruent pentagons are each formed by removing a right-angled isosceles triangle from a square of side-length 1. The two pentagons are then fitted together as shown.



What is the length of the perimeter of the octagon formed?

A 4 B $4+2\sqrt{2}$ C 5 D $6-2\sqrt{2}$ E 6

12. A three-piece suit consists of a jacket, a pair of trousers and a waistcoat. Two jackets and three pairs of trousers cost £380. A pair of trousers costs the same as two waistcoats.

What is the cost of a three-piece suit?

A £150 B £190 C £200 D £228
E more information needed

13. The number $16! \div 2^k$ is an odd integer. Note that $n! = 1 \times 2 \times 3 \times \cdots \times (n-1) \times n$.

What is the value of k?

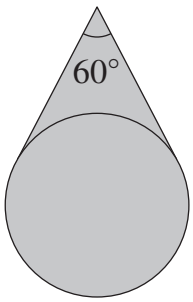
A 9 B 11 C 13 D 15 E 17

14. Diane has five identical blue disks, two identical red disks and one yellow disk. She wants to place them on the grid opposite so that each cell contains exactly one disk. The two red disks are not to be placed in cells that share a common edge.

How many different-looking completed grids can she produce?

A 96 B 108 C 144 D 180 E 216

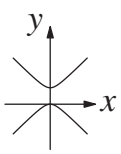
15. The shaded area shown in the diagram consists of the interior of a circle of radius 3 together with the area between the circle and two tangents to the circle. The angle between the tangents at the point where they meet is 60°.

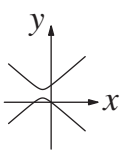


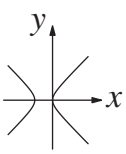
What is the shaded area?

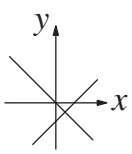
A $6\pi + 9\sqrt{3}$ B $15\sqrt{3}$ C 9π D $9\pi + 4\sqrt{3}$ E $6\pi + \frac{9\sqrt{3}}{4}$

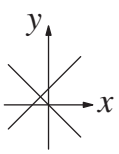
16. Which diagram represents the set of all points (x, y) satisfying $y^2 - 2y = x^2 + 2x$?

A 

B 

C 

D 

E 

17. The positive integers m, n and p satisfy the equation $3m + \dfrac{3}{n + \frac{1}{p}} = 17$.

What is the value of p?

A 2 B 3 C 4 D 6 E 9

18. Two circles C_1 and C_2 have their centres at the point (3,4) and touch a third circle, C_3. The centre of C_3 is at the point (0,0) and its radius is 2.

What is the sum of the radii of the two circles C_1 and C_2?

A 6 B 7 C 8 D 9 E 10

19. The letters p, q, r, s and t represent different positive single-digit numbers such that $p - q = r$ and $r - s = t$.

How many different values could t have?

A 6 B 5 C 4 D 3 E 2

20. The real numbers x and y satisfy the equations $4^y = \dfrac{1}{8(\sqrt{2})^{x+2}}$ and $9^x \times 3^y = 3\sqrt{3}$.

What is the value of 5^{x+y}?

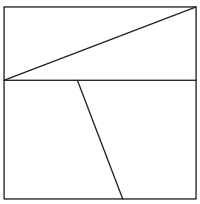
A $5\sqrt{5}$ B 5 C $\sqrt{5}$ D $\frac{1}{5}$ E $\frac{1}{\sqrt{5}}$

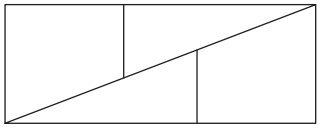
21. When written out in full, the number $(10^{2020} + 2020)^2$ has 4041 digits.

What is the sum of the digits of this 4041-digit number?

A 9 B 17 C 25 D 2048 E 4041

22. A square with perimeter 4 cm can be cut into two congruent right-angled triangles and two congruent trapezia as shown in the first diagram in such a way that the four pieces can be rearranged to form the rectangle shown in the second diagram.





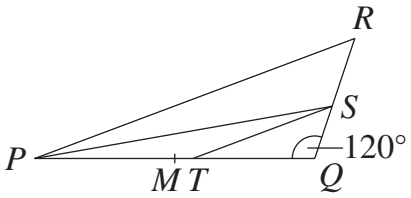
What is the perimeter, in centimetres, of this rectangle?

A $2\sqrt{5}$ B $4\sqrt{2}$ C 5 D $4\sqrt{3}$ E $3\sqrt{7}$

23. A function f satisfies $y^3 f(x) = x^3 f(y)$ and $f(3) \neq 0$. What is the value of $\dfrac{f(20) - f(2)}{f(3)}$?

A 6 B 20 C 216 D 296 E 2023

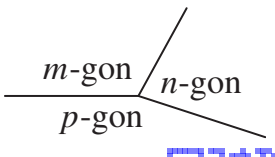
24. In the diagram shown, M is the mid-point of PQ. The line PS bisects $\angle RPQ$ and intersects RQ at S. The line ST is parallel to PR and intersects PQ at T. The length of PQ is 12 and the length of MT is 1. The angle SQT is 120°.



What is the length of SQ?

A 2 B 3 C 3.5 D 4 E 5

25. A regular m-gon, a regular n-gon and a regular p-gon share a vertex and pairwise share edges, as shown in the diagram.



What is the largest possible value of p?

A 6 B 20 C 42 D 50 E 100

1. What is the value of $123^2 - 23^2$?

A 10 000 B 10 409 C 12 323 D 14 600 E 15 658

2. What is the value of $(2019 - (2000 - (10 - 9))) - (2000 - (10 - (9 - 2019)))$?

A 4040 B 40 C -400 D -4002 E -4020

3. Used in measuring the width of a wire, one mil is equal to one thousandth of an inch. An inch is about 2.5 cm.

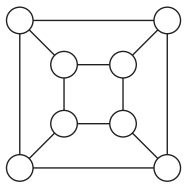
Which of these is approximately equal to one mil?

A $\frac{1}{40}$ mm B $\frac{1}{25}$ mm C $\frac{1}{4}$ mm D 25 mm E 40 mm

4. For how many positive integer values of n is $n^2 + 2n$ prime?

A 0 B 1 C 2 D 3 E more than 3

5. Olive Green wishes to colour all the circles in the diagram so that, for each circle, there is exactly one circle of the same colour joined to it.



What is the smallest number of colours that Olive needs to complete this task?

A 1 B 2 C 3 D 4 E 5

6. Each of the factors of 100 is to be placed in a 3 by 3 grid, one per cell, in such a way that the products of the three numbers in each row, column and diagonal are all equal. The positions of the numbers 1, 2, 50 and x are shown in the diagram.

x	1	50
2		

What is the value of x?

A 4 B 5 C 10 D 20 E 25

7. Lucy is asked to choose p, q, r and s to be the numbers 1, 2, 3 and 4, in some order, so as to make the value of $\frac{p}{q} + \frac{r}{s}$ as small as possible.

What is the smallest value Lucy can achieve in this way?

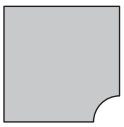
A $\frac{7}{12}$ B $\frac{2}{3}$ C $\frac{3}{4}$ D $\frac{5}{6}$ E $\frac{11}{12}$

8. The number x is the solution to the equation $3^{(3^x)} = 333$.

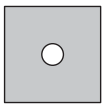
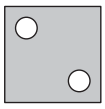
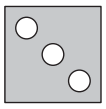
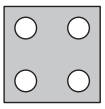
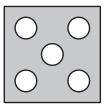
Which of the following is true?

A $0 < x < 1$ B $1 < x < 2$ C $2 < x < 3$ D $3 < x < 4$ E $4 < x < 5$

9. A square of paper is folded in half four times to obtain a smaller square. Then a corner is removed as shown.



Which of the following could be the paper after it is unfolded?

A  B  C  D  E 

10. Which of the following five values of n is a counterexample to the statement in the box below?

For a positive integer n, at least one of $6n - 1$ and $6n + 1$ is prime.

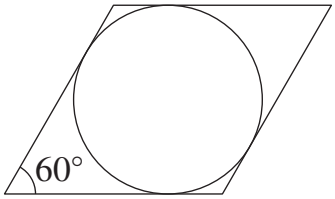
A 10 B 19 C 20 D 21 E 30

11. For how many integer values of k is $\sqrt{200 - \sqrt{k}}$ also an integer?

A 11 B 13 C 15 D 17 E 20

12. A circle with radius 1 touches the sides of a rhombus, as shown. Each of the smaller angles between the sides of the rhombus is 60°.

What is the area of the rhombus?



A 6 B 4 C $2\sqrt{3}$ D $3\sqrt{3}$ E $\frac{8\sqrt{3}}{3}$

13. Anish has a number of small congruent square tiles to use in a mosaic. When he forms the tiles into a square of side n, he has 64 tiles left over. When he tries to form the tiles into a square of side $n + 1$, he has 25 too few.

How many tiles does Anish have?

A 89 B 1935 C 1980 D 2000 E 2019

14. One of the following is the largest square that is a factor of 10!. Which one?

Note that, $n! = 1 \times 2 \times 3 \times \cdots \times (n - 1) \times n$.

A $(4!)^2$ B $(5!)^2$ C $(6!)^2$ D $(7!)^2$ E $(8!)^2$

15. The highest common factors of all the pairs chosen from the positive integers Q, R and S are three different primes.

What is the smallest possible value of $Q + R + S$?

A 41 B 31 C 30 D 21 E 10

16. The numbers x, y and z satisfy the equations $9x + 3y - 5z = -4$ and $5x + 2y - 2z = 13$.

What is the mean of x, y and z?

A 10 B 11 C 12 D 13 E 14

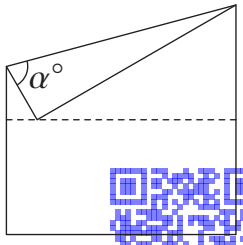
17. Jeroen writes a list of 2019 consecutive integers. The sum of his integers is 2019.

What is the product of all the integers in Jeroen's list?

A 2019^2 B $\frac{2019 \times 2020}{2}$ C 2^{2019} D 2019 E 0

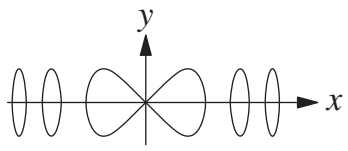
18. Alison folds a square piece of paper in half along the dashed line shown in the diagram. After opening the paper out again, she then folds one of the corners onto the dashed line.

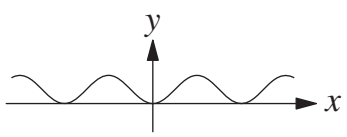
What is the value of α?

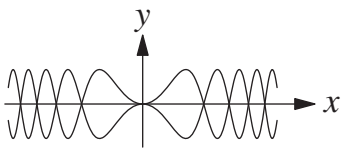


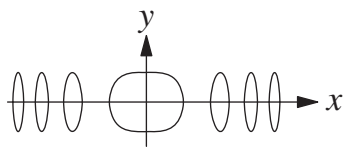
A 45 B 60 C 65 D 70 E 75

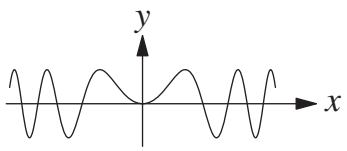
19. Which of the following could be the graph of $y^2 = \sin(x^2)$?

A 

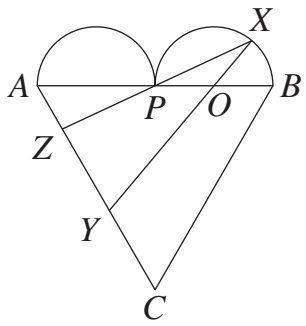
B 

C 

D 

E 

20. The "heart" shown in the diagram is formed from an equilateral triangle ABC and two congruent semicircles on AB. The two semicircles meet at the point P. The point O is the centre of one of the semicircles. On the semicircle with centre O, lies a point X. The lines XO and XP are extended to meet AC at Y and Z respectively. The lines XY and XZ are of equal length.



What is $\angle ZXY$?

A 20° B 25° C 30° D 40° E 45°

21. In a square garden $PQRT$ of side 10 m, a ladybird sets off from Q and moves along edge QR at 30 cm per minute. At the same time, a spider sets off from R and moves along edge RT at 40 cm per minute.

What will be the shortest distance between them, in metres?

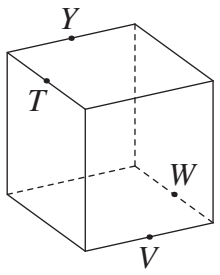
A 5 B 6 C $5\sqrt{2}$ D 8 E 10

22. A function f satisfies the equation $(n - 2019)f(n) - f(2019 - n) = 2019$ for every integer n.

What is the value of $f(2019)$?

A 0 B 1 C 2018×2019 D 2019^2 E 2019×2020

23. The edge-length of the solid cube shown is 2. A single plane cut goes through the points Y, T, V and W which are midpoints of the edges of the cube, as shown.



What is the area of the cross-section?

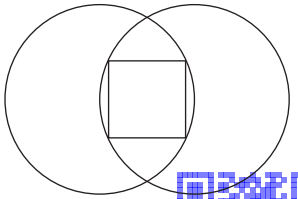
A $\sqrt{3}$ B $3\sqrt{3}$ C 6 D $6\sqrt{2}$ E 8

24. The numbers x, y and z are given by $x = \sqrt{12 - 3\sqrt{7}} - \sqrt{12 + 3\sqrt{7}}$, $y = \sqrt{7 - 4\sqrt{3}} - \sqrt{7 + 4\sqrt{3}}$ and $z = \sqrt{2 + \sqrt{3}} - \sqrt{2 - \sqrt{3}}$.

What is the value of xyz ?

A 1 B –6 C –8 D 18 E 12

25. Two circles of radius 1 are such that the centre of each circle lies on the other circle. A square is inscribed in the space between the circles.



What is the area of the square?

A $2 - \frac{\sqrt{7}}{2}$ B $2 + \frac{\sqrt{7}}{2}$ C $4 - \sqrt{5}$ D 1 E $\frac{\sqrt{5}}{5}$

1. When the following are evaluated, how many of the answers are odd numbers?

$$1^2,\ 2^3,\ 3^4,\ 4^5,\ 5^6$$

A 1 B 2 C 3 D 4 E 5

2. The positive integer 2018 is the product of two primes.

What is the sum of these two primes?

A 1001 B 1010 C 1011 D 1100 E 1101

3. Which of the following shows the digit 6 after it has been rotated clockwise through 135°?

A  B  C  D  E 

4. Which of the following is not a multiple of 5?

A $2019^2 - 2014^2$ B $2019^2 \times 10^2$ C $2020^2 \div 101^2$ D $2010^2 - 2005^2$
E $2015^2 \div 5^2$

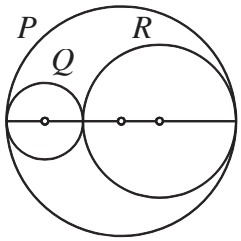
5. Which of the following numbers is the largest?

A $\frac{397}{101}$ B $\frac{487}{121}$ C $\frac{596}{153}$ D $\frac{678}{173}$ E $\frac{796}{203}$

6. Which of the following is equal to $25 \times 15 \times 9 \times 5.4 \times 3.24$?

A 3^9 B 3^{10} C 3^{11} D 3^{14} E 3^{17}

7. The circles P, Q and R are all tangent to each other. Their centres all lie on a diameter of P, as shown in the figure.



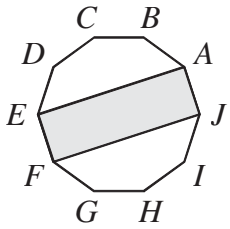
What is the value of $\dfrac{\text{circumference of } Q + \text{circumference of } R}{\text{circumference of } P}$?

A 1 B $\frac{1}{2}$ C $\frac{1}{3}$ D $\frac{1}{4}$
E more information needed

8. What are the last two digits of 7^{2018}?

A 07 B 49 C 43 D 01 E 18

9. The diagram shows a rectangle $AEFJ$ inside a regular decagon $ABCDEFGHIJ$.



What is the ratio of the area of the rectangle to the area of the decagon?

A 2 : 5 B 1 : 4 C 3 : 5 D 3 : 10 E 3 : 20

10. On a training ride, Laura averages speeds of 12 km/h for 5 minutes, then 15 km/h for 10 minutes and finally 18 km/h for 15 minutes.

What was her average speed over the whole ride?

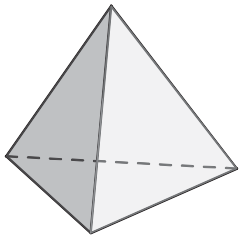
A 13 km/h B 14 km/h C 15 km/h D 16 km/h E 17 km/h

11. How many of the following four equations has a graph that does *not* pass through the origin?

$$y = x^4 + 1 \qquad y = x^4 + x \qquad y = x^4 + x^2 \qquad y = x^4 + x^3$$

A 0 B 1 C 2 D 3 E 4

12. A regular tetrahedron is a polyhedron with four faces, each of which is an equilateral triangle, as shown. A solid regular tetrahedron is cut into two pieces by a single plane cut.



Which of the following could *not* be the shape of the section formed by the cut?

A a pentagon B a square
C a rectangle that is not a square D a trapezium
E a triangle that is not equilateral

13. The lines $y = x$ and $y = mx - 4$ intersect at the point P.

What is the sum of the positive integer values of m for which the coordinates of P are also positive integers?

A 3 B 5 C 7 D 8 E 10

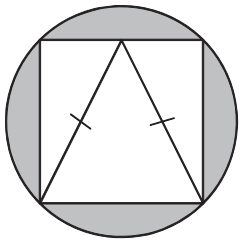
14. The following twelve integers are written in ascending order:

$$1, x, x, x, y, y, y, y, y, 8, 9, 11.$$

The mean of these twelve integers is 7. What is the median?

A 6 B 7 C 7.5 D 8 E 9

15. A square is inscribed in a circle of radius 1. An isosceles triangle is inscribed in the square as shown.



What is the ratio of the area of this triangle to the area of the shaded region?

A $\pi : \sqrt{2}$ B $\pi : 1$ C $1 : 4$ D $1 : \pi - 2$ E $2 : \pi$

16. The numbers p, q, r and s satisfy the following equations:

$$p + 2q + 3r + 4s = k \qquad 4p = 3q = 2r = s.$$

What is the smallest value of k for which p, q, r and s are all positive integers?

A 20 B 24 C 25 D 77 E 154

17. Bethany has 11 pound coins and some 20p coins and some 50p coins in her purse. The mean value of the coins is 52 pence.

Which could not be the number of coins in the purse?

A 35 B 40 C 50 D 65 E 95

18. P, Q and R are the three angles of a triangle, when each has been rounded to the nearest degree.

Which of the following is the complete list of possible values of $P + Q + R$?

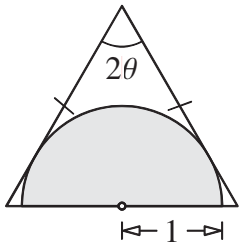
A 179°, 180° or 181° B 180°, 181° or 182° C 178°, 179° or 180° D 180°
E 178°, 179°, 180°, 181° or 182°

19. How many pairs of numbers (m, n) are there such that the following statement is true?

'A regular m-sided polygon has an exterior angle of size $n°$ and a regular n-sided polygon has an exterior angle of size $m°$.'

A 24 B 22 C 20 D 18 E 16

20. The diagram shows a semicircle of radius 1 inside an isosceles triangle. The diameter of the semicircle lies along the 'base' of the triangle, and the angle of the triangle opposite the 'base' is equal to 2θ. Each of the two equal sides of the triangle is tangent to the semicircle.



What is the area of the triangle?

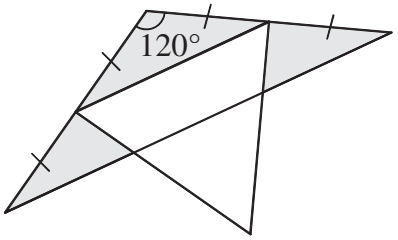
A $\frac{1}{2}\tan 2\theta$ B $\sin\theta\cos\theta$ C $\sin\theta+\cos\theta$ D $\frac{1}{2}\cos 2\theta$ E $\dfrac{1}{\sin\theta\cos\theta}$

21. The graph of $y=\dfrac{1}{x}$ is reflected in the line $y=1$. The resulting image is reflected in the line $y=-x$.

What is the equation of the final graph?

A $y=\dfrac{-1}{(x+2)}$ B $y=\dfrac{1}{(x-1)}$ C $y=\dfrac{1}{(x-2)}$ D $y=\dfrac{-1}{(x-1)}$ E $y=\dfrac{-1}{(x-2)}$

22. The diagram shows two overlapping triangles; an isosceles triangle with an angle of 120° and an equilateral triangle with area 36. Two of the vertices of the equilateral triangle are midpoints of the equal sides of the isosceles triangle.



What is the total area of the shaded regions (inside the isosceles triangle but outside the equilateral triangle)?

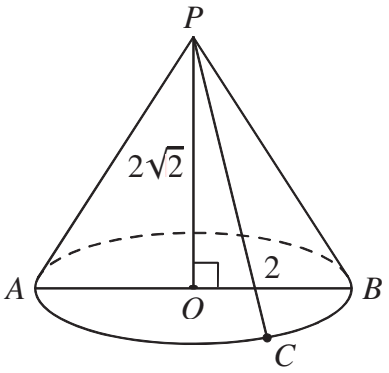
A 24 B 26 C 28 D 30 E 32

23. For particular real numbers a and b, the function f is defined by $f(x)=ax+b$, and is such that $f\big(f\big(f(x)\big)\big)=27x-52$.

Which of the following formulas defines the function g such that, for all values of x, $g\big(f(x)\big)=x$?

A $\frac{1}{3}x-4$ B $\frac{1}{3}x+\frac{4}{3}$ C $4x-3$ D $\frac{1}{3}x-\frac{4}{3}$ E $3x-4$

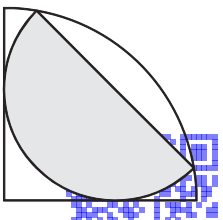
24. The diagram shows a circle with centre O which lies in a horizontal plane. The diameter AB has length 4. Point P lies vertically above O and $PO=2\sqrt{2}$. Point C lies on the semicircular arc AB such that the ratio of the lengths of the arcs AC and CB is 2 : 1.



What is the shortest distance from A to PC?

A $\sqrt{2}$ B $\sqrt{3}$ C 2 D $2\sqrt{2}$ E 3

25. A semicircle is inscribed in a quarter circle as shown.



What fraction of the quarter circle is shaded?

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

1. One of the following numbers is prime. Which is it?

   A $2017 - 2$ B $2017 - 1$ C 2017 D $2017 + 1$ E $2017 + 2$

2. Last year, an earthworm from Wigan named Dave wriggled into the record books as the largest found in the UK. Dave was 40 cm long and had a mass of 26 g. What was Dave's mass per unit length?

   A 0.6 g/cm B 0.65 g/cm C 0.75 g/cm D 1.6 g/cm E 1.75 g/cm

3. The five integers 2, 5, 6, 9, 14 are arranged into a different order. In the new arrangement, the sum of the first three integers is equal to the sum of the last three integers. What is the middle number in the new arrangement?

   A 2 B 5 C 6 D 9 E 14

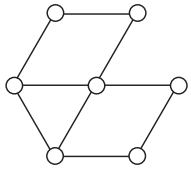
4. Which of the following is equal to $2017 - \dfrac{1}{2017}$?

   A $\dfrac{2017^2}{2016}$ B $\dfrac{2016}{2017}$ C $\dfrac{2018}{2017}$ D $\dfrac{4059}{2017}$ E $\dfrac{2018 \times 2016}{2017}$

5. One light-year is nearly 6×10^{12} miles. In 2016, the Hubble Space Telescope set a new cosmic record, observing a galaxy 13.4 thousand million light-years away. Roughly how many miles is that?

   A 8×10^{20} B 8×10^{21} C 8×10^{22} D 8×10^{23} E 8×10^{24}

6. The circles in the diagram are to be coloured so that any two circles connected by a line segment have different colours. What is the smallest number of colours required?



   A 2 B 3 C 4 D 5 E 6

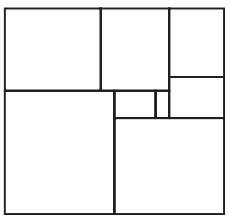
7. The positive integer k satisfies the equation $\sqrt{2} + \sqrt{8} + \sqrt{18} = \sqrt{k}$. What is the value of k?

   A 28 B 36 C 72 D 128 E 288

8. When evaluated, which of the following is not an integer?

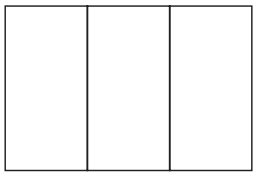
   A 1^{-1} B $4^{-\frac{1}{2}}$ C 6^0 D $8^{\frac{2}{3}}$ E $16^{\frac{3}{4}}$

9. The diagram shows an $n \times (n+1)$ rectangle tiled with $k \times (k+1)$ rectangles, where n and k are integers and k takes each value from 1 to 8 inclusive. What is the value of n?



   A 16 B 15 C 14 D 13 E 12

10. A rectangle is divided into three smaller congruent rectangles as shown. Each smaller rectangle is similar to the large rectangle. In each of these four rectangles, what is the ratio of the length of a longer side to that of a shorter side?

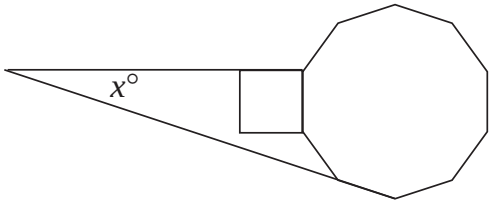


   A $2\sqrt{3} : 1$ B $3 : 1$ C $2 : 1$ D $\sqrt{3} : 1$ E $\sqrt{2} : 1$

11. The teenagers Sam and Jo notice the following facts about their ages:
The difference between the squares of their ages is four times the sum of their ages.
The sum of their ages is eight times the difference between their ages.
What is the age of the older of the two?

A 15 B 16 C 17 D 18 E 19

12. The diagram shows a square and a regular decagon that share an edge. One side of the square is extended to meet an extended side of the decagon.
What is the value of x?

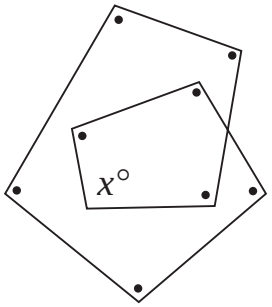


A 15 B 18 C 21 D 24 E 27

13. Isobel: "Josh is innocent" Genotan: "Tegan is guilty"
Josh: "Genotan is guilty" Tegan: "Isobel is innocent"
Only the guilty person is lying; all the others are telling the truth. Who is guilty?

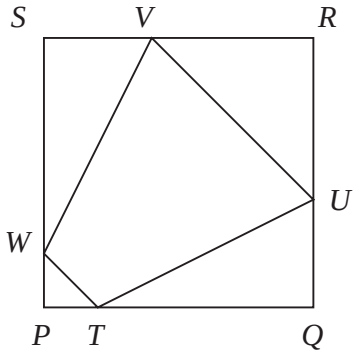
A Isobel B Josh C Genotan D Tegan E More information required

14. In the diagram, all the angles marked • are equal in size to the angle marked $x°$.
What is the value of x?



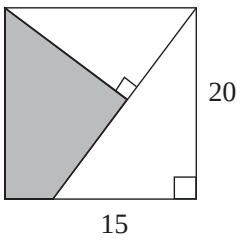
A 100 B 105 C 110 D 115 E 120

15. The diagram shows a square $PQRS$. Points T, U, V and W lie on the edges of the square as shown, such that $PT = 1$, $QU = 2$, $RV = 3$ and $SW = 4$. The area of $TUVW$ is half that of $PQRS$. What is the length of PQ?



A 5 B 6 C 7 D 8 E 9

16. The diagram shows two right-angled triangles inside a square. The perpendicular edges of the larger triangle have lengths 15 and 20.
What is the area of the shaded quadrilateral?



A 142 B 146 C 150 D 154 E 158

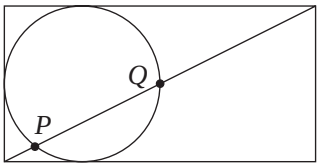
17. Amy, Beth and Claire each has some sweets. Amy gives one third of her sweets to Beth. Beth gives one third of all the sweets she now has to Claire. Then Claire gives one third of all the sweets she now has to Amy. All the girls end up having the same number of sweets.
Claire begins with 40 sweets. How many sweets does Beth have originally?

A 20 B 30 C 40 D 50 E 60

18. The arithmetic mean, A, of any two positive numbers x and y is defined to be $A = \frac{1}{2}(x + y)$ and their geometric mean, G, is defined to be $G = \sqrt{xy}$. For two particular values x and y, with $x > y$, the ratio $A : G = 5 : 4$. For these values of x and y, what is the ratio $x : y$?

A $5 : 4$ B $2 : 1$ C $5 : 2$ D $7 : 2$ E $4 : 1$

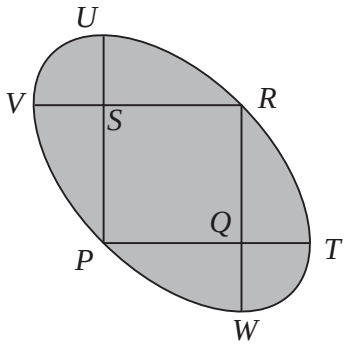
19. The diagram shows a circle of radius 1 touching three sides of a 2×4 rectangle. A diagonal of the rectangle intersects the circle at P and Q, as shown. What is the length of the chord PQ?



A $\sqrt{5}$ B $\dfrac{4}{\sqrt{5}}$ C $\sqrt{5} - \dfrac{2}{\sqrt{5}}$ D $\dfrac{5\sqrt{5}}{6}$ E 2

20. The diagram shows a square $PQRS$ with edges of length 1, and four arcs, each of which is a quarter of a circle. Arc TRU has centre P; arc VPW has centre R; arc UV has centre S; and arc WT has centre Q.

What is the length of the perimeter of the shaded region?



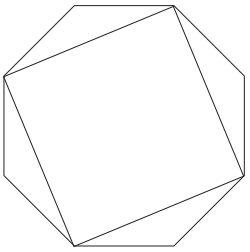
A 6 B $(2\sqrt{2} - 1)\pi$ C $(\sqrt{2} - \frac{1}{2})\pi$
D 2π E $(3\sqrt{2} - 2)\pi$

21. How many pairs (x, y) of positive integers satisfy the equation $4^x = y^2 + 15$?

A 0 B 1 C 2 D 4 E an infinite number

22. The diagram shows a regular octagon and a square formed by drawing four diagonals of the octagon. The edges of the square have length 1.

What is the area of the octagon?



A $\dfrac{\sqrt{6}}{2}$ B $\dfrac{4}{3}$ C $\dfrac{7}{5}$ D $\sqrt{2}$ E $\dfrac{3}{2}$

23. The parabola with equation $y = x^2$ is reflected in the line with equation $y = x + 2$. Which of the following is the equation of the reflected parabola?

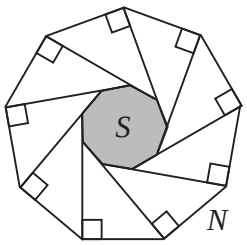
A $x = y^2 + 4y + 2$ B $x = y^2 + 4y - 2$ C $x = y^2 - 4y + 2$
D $x = y^2 - 4y - 2$ E $x = y^2 + 2$

24. There is a set of straight lines in a plane such that each line intersects exactly ten others. Which of the following could not be the number of lines in that set?

A 11 B 12 C 15 D 16 E 20

25. The diagram shows a regular nonagon N. Moving clockwise around N, at each vertex a line segment is drawn perpendicular to the preceding edge. This produces a smaller nonagon S, shown shaded.

What fraction of the area of N is the area of S?



A $\dfrac{1 - \cos 40^\circ}{1 + \cos 40^\circ}$ B $\dfrac{\cos 40^\circ}{1 + \cos 40^\circ}$ C $\dfrac{\sin 40^\circ}{1 + \sin 40^\circ}$ D $\dfrac{1 - \sin 40^\circ}{1 + \sin 40^\circ}$ E $\dfrac{1}{9}$

[THIS PAGE IS INTENTIONALLY LEFT BLANK.]