England & Wales: Year 9 or below
Scotland: S2 or below
Northern Ireland: Year 10 or below

Instructions

1. Do not open the paper until the invigilator tells you to do so.

2. Time allowed: **60 minutes**.
   No answers, or personal details, may be entered after the allowed time is over.

3. The use of blank or lined paper for rough working is allowed; **squared paper**, **calculators and measuring instruments are forbidden**.

4. **Use a B or an HB non-propelling pencil.** Mark at most one of the options A, B, C, D, E on the Answer Sheet for each question. Do not mark more than one option.

5. **Do not expect to finish the whole paper in the time allowed.** The questions in this paper have been arranged in approximate order of difficulty with the harder questions towards the end. You are not expected to complete all the questions during the time. You should bear this in mind when deciding which questions to tackle.

6. **Scoring rules:**
   5 marks are awarded for each correct answer to Questions 1-15;
   6 marks are awarded for each correct answer to Questions 16-25;
   In this paper you will not lose marks for getting answers wrong.

7. Your Answer Sheet will be read by a machine. **Do not write or doodle on the sheet except to mark your chosen options.** The machine will read all black pencil markings even if they are in the wrong places. If you mark the sheet in the wrong place, or leave bits of eraser stuck to the page, the machine will interpret the mark in its own way.

8. **The questions on this paper are designed to challenge you to think, not to guess.** You will gain more marks, and more satisfaction, by doing one question carefully than by guessing lots of answers. This paper is about solving interesting problems, not about lucky guessing.
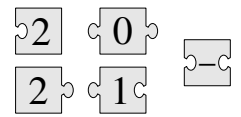
1. What is the value of $\dfrac{20 \times 21}{2 + 0 + 2 + 1}$?

    A   42   B   64   C   80   D   84   E   105

2. When the five pieces shown are fitted together correctly, the result is a rectangle with a calculation written on it. What is the answer to this calculation?

    A   −100   B   −8   C   −1   D   199   E   208

3. Each of the five vases shown has the same height and each has a volume of 1 litre. Half a litre of water is poured into each vase. In which vase would the level of the water be the highest?

    A   B   C   D   E
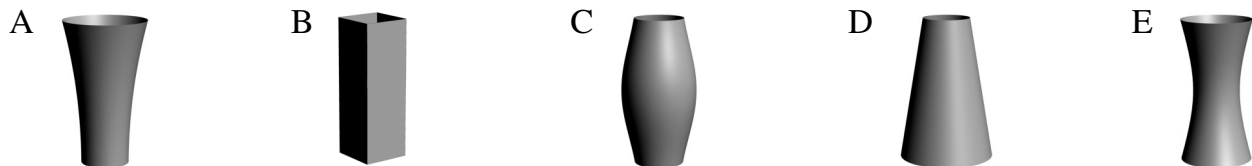
4. A student correctly added the two two-digit numbers on the left of the board and got the answer 137. What answer will she obtain if she adds the two four-digit numbers on the right of the board?

$$\begin{array}{r} A\,B \\ +\,C\,D \\ \hline 1\;3\;7 \end{array} \qquad \begin{array}{r} A\,D\,C\,B \\ +\,C\,B\,A\,D \\ \hline ? \end{array}$$

    A   13737   B   13837   C   14747   D   23723   E   137137

5. A bike lock has four wheels numbered with the digits 0 to 9 in order. Each of the four wheels is rotated by 180° from the code shown in the first diagram to get the correct code. What is the correct code for the bike lock?

    A   0815   B   1893   C   1972   D   4892   E   8436

6. A rectangular chocolate bar is made of equal squares. Irena breaks off two complete strips of squares and eats the 12 squares she obtains. Later, Jack breaks off one complete strip of squares from the same bar and eats the 9 squares he obtains. How many squares of chocolate are left in the bar?
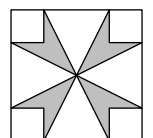
    A   72   B   63   C   54   D   45   E   36

7. When a jar is one-fifth filled with water, it weighs 560 g. When the same jar is four-fifths filled with water, it weighs 740 g. What is the weight of the empty jar?

    A   60 g   B   112 g   C   180 g   D   300 g   E   500 g

8. In the diagram, the area of the large square is 16 cm^2 and the area of each small corner square is 1 cm^2. What is the shaded area?

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

9. Costa is building a new fence in his garden. He uses 25 planks of wood, each of which is 30 cm long. He arranges these planks so that there is the same slight overlap between any two adjacent planks, as shown in the diagram. The total length of Costa's new fence is 6.9 metres. What is the length in centimetres of the overlap between any pair of adjacent planks?

   A   2.4   B   2.5   C   3   D   4.8   E   5

10. Five identical right-angled triangles can be arranged so that their larger acute angles touch to form the star shown in the diagram. It is also possible to form a different star by arranging more of these triangles so that their smaller acute angles touch. How many triangles are needed to form the second star?

    A 10   B 12   C 18   D 20   E 24

11. Five squares are positioned as shown. The small square indicated has area 1. What is the value of h?

   A 3   B 3.5   C 4   D 4.2   E 4.5
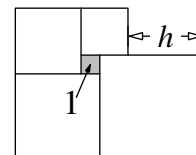
12. There are 20 questions in a quiz. Seven points are awarded for each correct answer, four points are deducted for each incorrect answer and no points are awarded or deducted for each question left blank.

Erica took the quiz and scored 100 points. How many questions did she leave blank?

    A 0   B 1   C 2   D 3   E 4

13. A rectangular strip of paper of dimensions 4×13 is folded as shown in the diagram. Two rectangles are formed with areas P and Q where $P = 2Q$. What is the value of x?

    A 5   B 5.5   C 6   D 6.5   E $4\sqrt{2}$
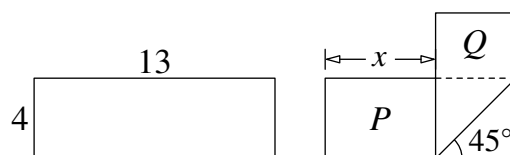
14. A box of fruit contained twice as many apples as pears. Chris and Lily divided them up so that Chris had twice as many pieces of fruit as Lily. Which one of the following statements is always true?

    A Chris took at least one pear.
    B Chris took twice as many apples as pears
    C Chris took twice as many apples as Lily.
    D Chris took as many apples as Lily took pears.
    E Chris took as many pears as Lily took apples.

15. Three villages are connected by paths as shown. From Downend to Uphill, the detour via Middleton is 1 km longer than the direct path. From Downend to Middleton, the detour via Uphill is 5 km longer than the direct path. From Uphill to Middleton, the detour via Downend is 7 km longer than the direct path. What is the length of the shortest of the three direct paths between the villages?
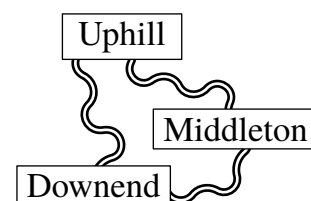
   A 1 km   B 2 km   C 3 km   D 4 km   E 5 km

16. In a particular fraction the numerator and denominator are both positive. The numerator of this fraction is increased by 40%. By what percentage should its denominator be decreased so that the new fraction is double the original fraction?

    A 10%   B 20%   C 30%   D 40%   E 50%

17. The six-digit number $2PQRST$ is multiplied by 3 and the result is the six-digit number $PQRST2$. What is the sum of the digits of the original number?

    A 24   B 27   C 30   D 33   E 36

18. A triangular pyramid is built with 20 cannonballs, as shown. Each cannonball is labelled with one of A, B, C, D or E. There are four cannonballs with each type of label.
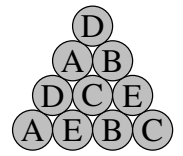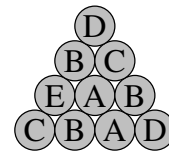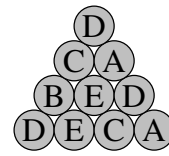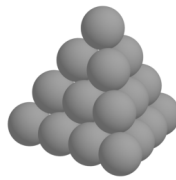

The diagrams show the labels on the cannonballs on three of the faces of the pyramid. What is the label on the hidden cannonball in the middle of the fourth face?

    A   B   C   D   E

19. A ball is made of white hexagons and black pentagons, as seen in the picture. There are 12 pentagons in total. How many hexagons are there?

    A 12   B 15   C 18   D 20   E 24

20. The positive integer N is the smallest one whose digits add to 41. What is the sum of the digits of $N + 2021$?

    A 10   B 12   C 16   D 2021   E 4042

21. The diagram shows a $3 \times 4 \times 5$ cuboid consisting of 60 identical small cubes. A termite eats its way along the diagonal from P to Q. This diagonal does not intersect the edges of any small cube inside the cuboid. How many of the small cubes does it pass through on its journey?
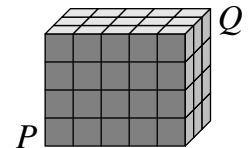
    A 8   B 9   C 10   D 11   E 12

22. Lewis and Geraint left Acaster to travel to Beetown at the same time. Lewis stopped for an hour in Beetown and then drove back towards Acaster. He drove at a constant 70 km/h. He met Geraint, who was cycling at a constant 30 km/h, 105 km from Beetown. How far is it from Acaster to Beetown?

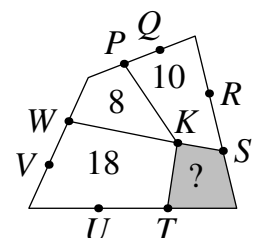   A 315 km   B 300 km   C 250 km   D 210 km   E 180 km

23. A total of 2021 coloured koalas are arranged in a row and are numbered from 1 to 2021. Each koala is coloured red, white or blue. Amongst any three consecutive koalas, there are always koalas of all three colours. Sheila guesses the colours of five koalas. These are her guesses: Koala 2 is white; Koala 20 is blue; Koala 202 is red; Koala 1002 is blue; Koala 2021 is white. Only one of her guesses is wrong. What is the number of the koala whose colour she guessed incorrectly?

    A 2   B 20   C 202   D 1002   E 2021

24. In a tournament each of the six teams plays one match against every other team. In each round of matches, three take place simultaneously. A TV station has already decided which match it will broadcast for each round, as shown in the diagram. In which round will team S play against team U?

1	2	3	4	5
P–Q	R–S	P–T	T–U	P–R

    A 1   B 2   C 3   D 4   E 5

25. The diagram shows a quadrilateral divided into four smaller quadrilaterals with a common vertex K. The other labelled points divide the sides of the large quadrilateral into three equal parts. The numbers indicate the areas of the corresponding small quadrilaterals. What is the area of the shaded quadrilateral?

    A 4   B 5   C 6   D 6.5   E 7