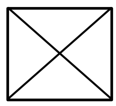
Primary Mathematics Challenge – February 2023
Answers and Notes

These notes provide a brief look at how the problems can be solved. There are sometimes many ways of approaching problems, and not all can be given here. Suggestions for further work based on some of these problems are also provided.

P1 C 150 cm (600 - 450 = 150) P2 E 9 (1 + 2 + 2 + 4 = 9)

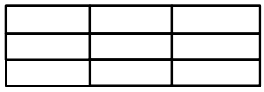
1	A	1/6	Pepper sleeps for 20 hours a day so she is awake for 4 out of 24 hours each day.
2	E	40p	The difference in the two prices is the cost of the peach. 140p - 100p = 40p
3	A	5	Starting with any number will give an answer of 5. We add 6, subtract 4 and add 3 giving 5.
4	A	kite	Three angles of the quadrilateral are 120°, 120°, 80°. The angles of quadrilaterals add up to 360°, so the fourth angle will be 40°. This quadrilateral cannot be a parallelogram, rectangle or rhombus as it does not have two pairs of equal angles. It cannot be a trapezium as it does not have two pairs of angles that add up to 180°. It can be a kite.
5	E	3 hr	6 miles at 3 mph takes 2 hours. Returning at twice the speed will take one hour. The total time is therefore 3 hours.
6	C	25	Gulpa has 30 cups of tea using each tea bag twice, so she uses 15 tea bags a week. Her husband has 30 cups of tea using each tea bag three times, so he uses 10 tea bags a week. The total 15 + 10 = 25 tea bags a week. (Maybe they drink different types of tea.)
7	E	10 min	10 teachers mark 10 books in 10 minutes. So 1 teacher can mark 10 books in 100 minutes, marking at the same rate. Therefore 1 teacher can mark 1 book in 10 minutes. (See the notes below)
8	A	6	Ben has filled 6 packets. If there were 5 rulers in each packet, he would have 7 left over; but In that case he would have started to fill another packet. If there were 6 rulers in each packet, he would have used 36 rulers and be starting on his 7th packet. This is his present situation. If there were 7 rulers in each packet, he would not be on his 7th packet. So Ben is putting 6 rulers in each packet.
9	D	135 cm	Three times dad's length is 3 × 180 = 540 cm. Dividing by 4 gives my length as 540 ÷ 4 = 135 cm.
10	C	£9	There is a 5% difference in price. If 5% of the full price is 45p then the full price was 20 x 45p = £9.
11	A	0	$2^4 = 2 \times 2 \times 2 \times 2 = 16$. $4^2 = 4 \times 4 = 16$. The difference is zero.
12	C	7	In any one game, one team is knocked out of the competition. So seven games are needed.
13	D	£20	In the first transaction Robyn makes a profit of £10. She does the same in the second transaction. The total profit is therefore £20.
14	D	24	Pupils can make a list of all the possibilities. Or calculate: there are four letters and so there are four possibilities for the first letter. This leaves three for the second, and two for the third. The total is 4 x 3 x 2 = 24. This includes words we recognise and nonsense words.
15	E	45	There is 1 very large box. There are 4 large boxes. These each contain two small boxes – there will be 8 of these. Each of these 8 small boxes contain 4 very small boxes – there will be 32 of these. Total: 1 + 4 + 8 + 32 = 45 boxes.
16	E	400 g	With 20 g mud, Maud uses 25 g slime and 5 g sand, which totals 50 g. Now, 1000 ÷ 50 = 20. So Maud needs 20 batches of mud which is 20 × 20 g = 400 g.
17	D	72 cm^2	The square contains 4 triangles with area ½ × 6 × 6 = 18 cm^2. So the area of the square is 4 × 18 = 72 cm^2.
18	C	105°	The angle between 3 and 6 o'clock is 90°. The hour hand is half-way between 2 and 3 o'clock; i.e. half of 30° = 15°. So the answer is 90° + 15° = 105°.
19	C	4	Each guard works for 12 hours for 4 days (requiring 2 guards for those 4 days). She then has 4 days off, during which 2 other guards are needed. Total: 4 guards. This pattern continues for the whole 80 days.
20	D	18	Of the five numbers suggested, 18 is the only one which, when halved, gives a square. And 18 does satisfy all four conditions.
21	B	0.3	The square root contains 90 ÷ 1000 = 0.09. $\sqrt{0.09} = 0.3$.
22	B	24	There are 6 squares which have 24 edges. These all touch the 24 edges of the 8 triangles. In total therefore there are 24 edges.



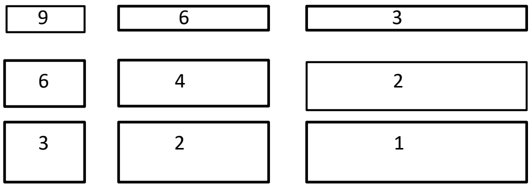
23	D	5050	This is the Bonus Round and pupils are expected to find an easy way to add these whole numbers. One way is to combine pairs of numbers all adding to 101 (e.g. 1 + 100). There will be 50 pairs of these numbers so the total of all the numbers is $50 \times 101 = 5050$.
24	A	23	Three classes have 30 pupils and we can deduce that they must be Year 1, Year 4 and Year 5. So Reception, Year 2 and Year 6 must all have 29 pupils. Adding up all these other classes ($3 \times 30 + 3 \times 29$) gives us 177 pupils. The total number of pupils is 200. So the number of pupils in Year 3 is 200 - 177 = 23.
25	A	5	If $W \times W = XW$, then W must be either 5 or 6 as this pattern cannot be found in other tables. But $Y \times W = ZW$ giving another part of the table ending in W again. This only occurs in the 5 times table. So W must be 5.

Some notes and possibilities for further problems

P2 Here is the 'next size' diagram. How many rectangles are there here?



There are rectangles with these shapes:



Total: 36.

Q3 Of course, algebra helps here. For this question, with x being any number we start with, then the expression becomes $x + 6 - 4 + 3 - x$ which equals 5 whatever the value of x.

Q4 What would happen if two angles of a quadrilateral each became closer to 180°? The quadrilateral would degenerate into a straight line!

Q7 The three-line solution above looks reasonable but it could have been written as:
10 teachers mark 10 books in 10 minutes.
So 10 teachers can mark 1 book in 1 minute. (It is difficult to imagine 10 teachers marking the same book.)
Therefore 1 teacher marks 1 book in 10 minutes.

Q11 Does $3^2 = 2^3$? Will the difference be zero for any numbers other than 2 and 4?

Q12 It is easy to draw a knock-out table for four, or 8 teams. But a 'bye' has to be used for any number of teams other than a power of 2. Pupils might enjoy drawing a knock-out table – see *Knockout Tournament Template at MyDraw*.

Q13 This is a version of a famous problem about a horse which many adults found difficult. You could do a web search: *Mumsnet: to think this sum is super simple* to see how some people worked it out. There are 22 pages of discussion!

Q14 How many words (including nonsense words) can be made from the letters of the word *MATHS* ?

Q17 The area of the square has been calculated and is 72 cm^2, but what is the length of each side of the square? This will be $\sqrt{72} \approx 8.48$ cm. The square has diagonals of whole number length, but the sides of the square have irrational lengths; i.e. these lengths cannot be written exactly in decimal form. The reverse will be true: for a square with sides 6 cm and area 36 cm^2, each of the four triangles will have an area of 9 cm^2. If x is the length of the shorter sides of these triangles, then $\frac{1}{2} \times x \times x = 9$. This gives $x^2 = 18$ and $x = \sqrt{18}$. The length of a diagonal is twice this and is another irrational number.

Q18 In shops many clock faces show the time 10 past 10 as the effect is cheerful and the manufacturer's name is shown between the hands. What is the angle between the hands of a clock which shows 10 minutes past 10?

Q22 A cube has 6 square faces. Each face has 4 sides touching the side of another square. So the total number of edges on a cube is $\frac{1}{2} \times 6 \times 4 = 12$. A tetrahedron has 4 triangular faces so the number of edges is $\frac{1}{2} \times 4 \times 3 = 6$. How many edges does an icosahedron (20 equilateral triangle faces) have?
Suppose you cut a small triangular pyramid off each vertex of a cube. If the pyramids that you remove are the right size then you get left with a cuboctahedron. A search for cuboctahedron provides some illustrations. A good book on this subject is *The Platonic Solids And Some Others* by John Parker. You can construct a net for a cuboctahedron using computer geometry, or ruler and protractor, or find one online.

Q23 Using the trick of adding pairs makes this sum easy, even for a large number of numbers such as: add numbers from 1 to 1000. But it is not so easy to use pairs for an odd number of numbers such as 1 to 11 because of one number left on its own in the middle. Carl Friedrich Gauss, a famous mathematician, was barely three years old he corrected a maths error his father made. We are told that, when he was seven, he discovered the method used in this problem to add together all the integers from 1 to 100.