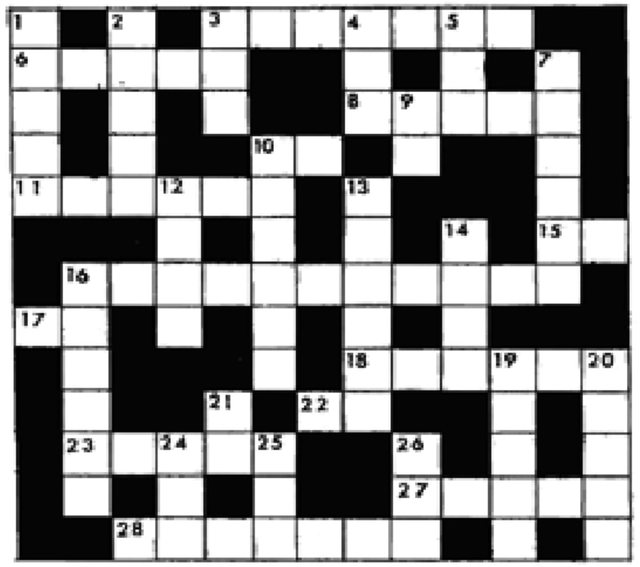
A CROSS PUZZLE

Submitted by H. Wright and R. Toye of
King Edward VI High School for Girls, Birmingham.



Ignore decimal points. Work to the required degree of accuracy but do not become illiterate nor innumerate.

Clues Across

3. We have Pythagoras'!
6. One decametre in millimetres.
8. 101 base two squared.
10. and 2 down -2 and $+2$ are – –. – – – – – of 4.
11. The sine table is a backward – – – – – – table.
15. Towards a number.
16. When gambling, it is advisable to know this before placing a bet.
17. Twice the cube root of $(\sqrt{25 \times 4})^3$ numerically.
18. The first six terms of the series $4n-4$ in modulo nine.
22. $\sqrt{(256)}$.
23. A TRIO (anag. One word).
27. log 33·98.
28. a^{-1} where $a \times a^{-1}$ = identity.

Clues Down

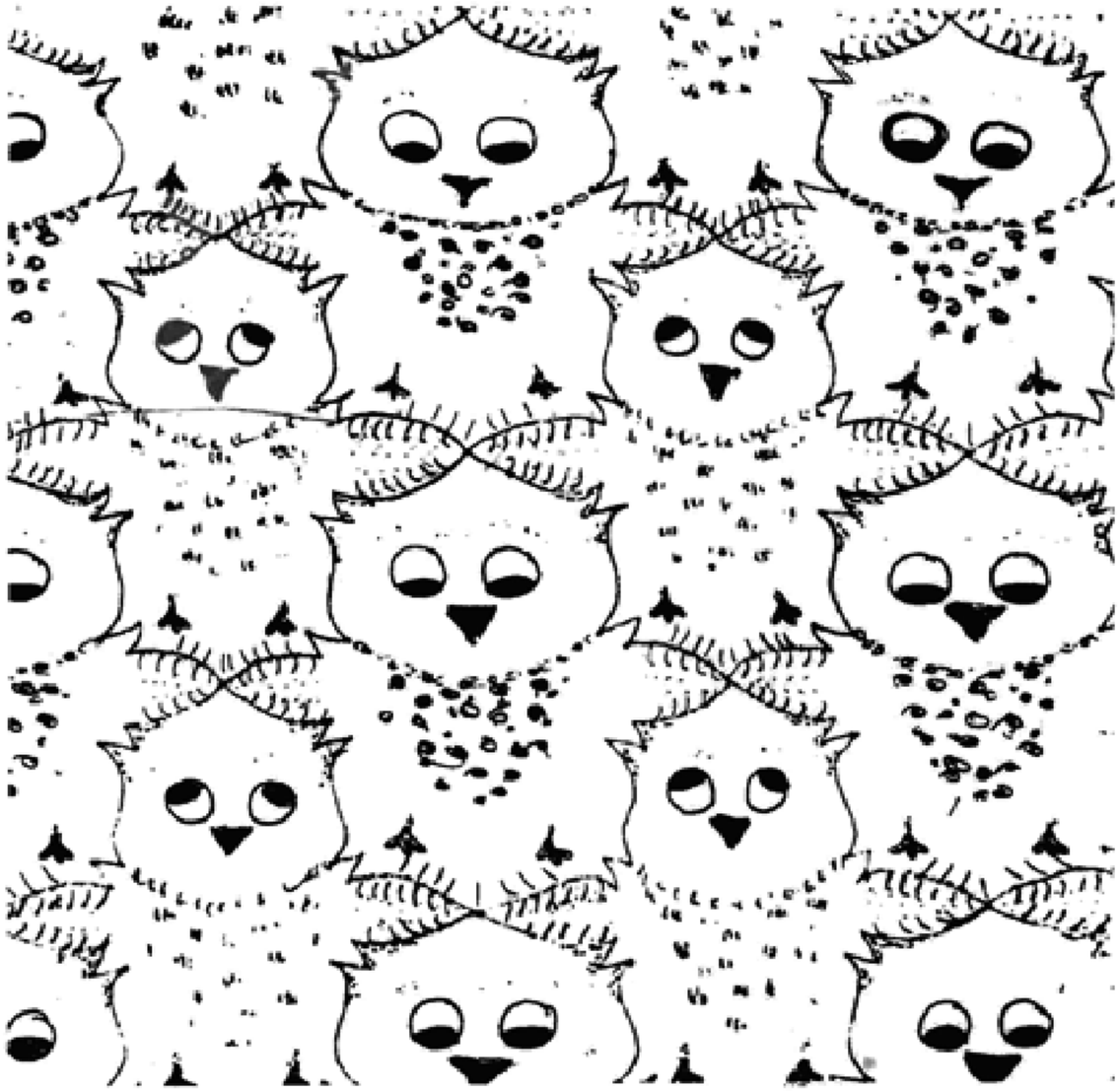
1. A reversed cubic.
2. See 10 across.
3. 80 quarters weigh one – – –.
4. $\frac{1}{100}$ as a decimal.
5. The opposite of 25 down.
7. 4×17 across, at length.
9. A dozen of a breadmaker.
10. Inverse of 11 across.
12. Using 3 across, find H^2 where $x = 30$ and $y = 26{\cdot}46$.
13. $3 \times 2 \times 5 \times 1{\cdot}004 + 6 \times 0{\cdot}0001$.
14. There are 60 in 1 hour time and x in the angle whose log sine is $\bar{1}{\cdot}7706$.
16. 10, 100 1000 are – – – – – – of 24 down.
19. 27 across plus 20 down.
20. $\log(6^3 - \sqrt[3]{216})$.
21. The sixth prime number.
24. anti-log 1·0000.
25. $(-1)^4$ in full.
26. A Greek letter? or a dessert?

join the mathematical pie in mathematical pie mathematical pie mathematical pie

No. 71 | *Editorial Address:* 31 Oldway Drive, Solihull, Warwickshire B91 3HP | SPRING, 1974

A WISE TESSELLATION

Submitted by Tina Lomas, Beaconsfield High School



NUMBER PATTERNS WITH SQUARES

Submitted by A. E. Orford, Felixstowe

Add successive squares

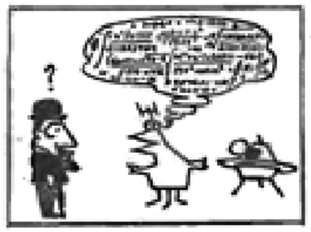
0	+	1	=	1	289	+ 324	= 613
1	+	4	=	5	324	+ 361	= 685
4	+	9	=	13	361	+ 400	= 761
9	+	16	=	25	400	+ 441	= 841
16	+	25	=	41	441	+ 484	= 925
25	+	36	=	61	484	+ 529	= 1013
36	+	49	=	85			
49	+	64	=	113			
64	+	81	=	145			
81	+	100	=	181			
100	+	121	=	221			
121	+	144	=	265			
144	+	169	=	313			
169	+	196	=	365			
196	+	225	=	421			
225	+	256	=	481			
256	+	289	=	565			

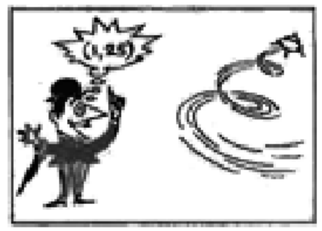
The units column is a repetition of the digits 1, 5, 3, 5, 1.

The tens column is an arrangement of the digits 1, 2, 4, 6, 8.

The numbers which precede the 13 termination are successive triangular numbers 1, 3, 6, 10.

The difference in the successive totals also follow a pattern, $2^2 \times 1$, $2^2 \times 2$, $2^2 \times 3$.





THE HAT TRICK

Here is a logical party game that will test your friends' powers of deduction. Take three green paper hats, or pieces of sticky tape, and three red hats, or pieces of sticky tape. Select three of your friends, blindfold them and stick a piece of green or red tape on their foreheads, or put hats on their heads—hiding the leftover props. Take off the blindfolds and then ask them to hold up their hand if they can see a red tape on one of the others. When this has been done offer a prize to the first one who can say what colour he has on his forehead.

What would you say if you were one of the players and one hand shot up? What about no hands going up? or two? or three? In each case considering (a) that your hand went up and (b) that your hand did not go up.

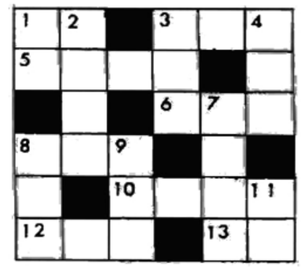
R.H.C.

CRISIS !

There are 365 days in a year. You sleep eight hours per day, or one-third of the time, deduct 122 days. Saturday and Sunday are not school days, deduct 104 days. Summer vacation is three months, deduct 90 days. Easter and Christmas vacations, deduct 19 days. Two hours per day eating amounts to 30 days per year. The number of days left to attend school is 0. Yippee—what went wrong?

R.H.C.

JUNIOR CROSS FIGURE No. 63



Ignore decimal points in solutions.

Clues Across

1. Total number of arrangements using all the letters MATH.
3. S13°W as a whole circle bearing.
5. Earth's circumference divided by its diameter.
6. Fourth vertex of a square with vertices (1,7), (4,3) and (8,6).
8. 2-down in base ten.
10. $2(2^5)^2$.
12. Value of x when $4x - 5 = 18$.
13. Area of square (in sq. units) in 6-across.

Clues Down

1. Perimeter of a rectangle of length 8cm and area 28cm^2.
2. 131×23 (base 5).
3. $\frac{1}{8}$ as a percentage.
4. $ab^2 - 3a^2b$ when $a = 5$, $b = 4$.
7. Eighteen minutes to six in the evening, as shown by the 24-hr. clock.
8. Smaller angle between hands of clock at 10.45.
9. Next term, as a decimal, in the series $4\frac{3}{4}$, $4\frac{3}{8}$, 4, $3\frac{5}{8}$, ...
11. 136 km hr^{-1} in m.p.h., taking 8 km to be equal to 5 miles.

D.I.B.

SOLUTIONS TO PROBLEMS IN ISSUE No. 70

ON THE TILES

The tiles should have sides 4cm., 3cm. and generally $(2 + \frac{2}{n})$ cm.

REPLAYS

There were 29 replays.

ODD OR EVEN

The difference is 25.

WRAP IT UP

The least number of books is 301.

BEHIND THE IRON CURTAIN

The sum was 425×382, giving an answer 163 350.

EQUALITIES

The statements (a) and (b) are true but the rest are not. To generalise the result $1 + 2 + \ldots + n = (n + 1) + (n + 2) + \ldots + (2n) = n^2$.

COVER UP

The length of sewing to be done will be smaller when the strips run parallel to the length.

SENIOR CROSS FIGURE No. 66

Clues Across: 1. 7563; 4. 15; 5. 4368; 6. 18; 7. 999; 9. 85; 10. 64; 11. 169; 13. 10; 14. 2112; 17. 95; 18. 1625.

Clues Down: 1. 78; 2. 648; 3. 33; 4. 18960; 6. 15625; 8. 94; 9. 81; 12. 91; 13. 126; 15. 11; 16. 25.

The clue 18 across should have read $a^2b^{-1}c^{-1} + a^4b^{-3}c^{-2}$.

LETTER FROM AUSTRALIA No. 2

6 points for a goal and 1 point for a behind.

JUNIOR CROSS FIGURE No. 62

Clues Across: 1. 144169; 5. 62; 6. 21; 8. 650; 10. 575; 12. 13; 13. 75; 15. 666667.

Clues Down: 1. 162536; 2. 46; 3. 126; 4. 910327; 7. 17; 9. 51; 11. 576; 14. 56.

IN THE SWIM

The man swimming across the river would win by 3 minutes 20 seconds.

B.A.

continued from previous page

The axes do not have to intersect to form an origin from which to mark the points and this will give you another way in which you can vary the design. More than two lines can be used and Fig. 4 shows the start of a pattern based on four lines in the shape of a kite, with N equally spaced points on each line, which, if joined with a continuous thread as follows, will produce a particularly pleasing and eye-catching pattern. Using our usual mapping notation and lines labelled A, B, C, D try $A_n \to B_n \to C_n \to D_n \to A_{n+1} \to B_{n+1}$, taking n from 1 to N in sequence until D_n is reached.

Finally, Fig. 5 shows a design based on two lines and a quadrant of a circle. Divide the quadrant and each radius into the same number of parts and label the points 1 to N. Use the mapping $A_n \to B_n \to C_n \to C_{n+1} \to A_{n+1} \to B_{n+1}$ for values of n from 1 to N.

There are ready made-up kits available in the shops but if you prefer to do-it-yourself—and save money—the only materials needed are $\frac{3}{8}$" or $\frac{1}{2}$" plywood, $\frac{3}{8}$" panel pins, some blackboard paint and lots of thread. Best results are obtained by putting the nails in position on the board before painting using two coats of paint. Tie the thread to the first nail and pass the thread round the second nail and on to the third, etc. DO NOT FORGET TO TIE THE THREAD TO THE LAST NAIL—or all will have been in vain.

P.J.G.

DICEY !

Your friends will find this difficult to believe : you present them with four dice and offer them the choice of which one they would prefer to use, explaining that you will then choose a die and will compete by throwing your dice together, the one throwing the higher score winning the throw. The dice are numbered strangely and your friend will take care with his choice. After playing for a while, foul play is suspected and a new choice demanded.

Next time, the die that you used will probably be chosen—you make a new choice and before long you are ahead again. Your friends will be completely perplexed as you seem able to win whichever die is chosen. Surely, there must be a best die ?

One set of number for the dice is :—

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

The table below shows that A beats B two-thirds of the time.

	3	4	5	20	21	22
1	A	A	A	A	A	A
2	A	A	A	A	A	A
16	B	B	B	A	A	A
17	B	B	B	A	A	A
18	B	B	B	A	A	A
19	B	B	B	A	A	A

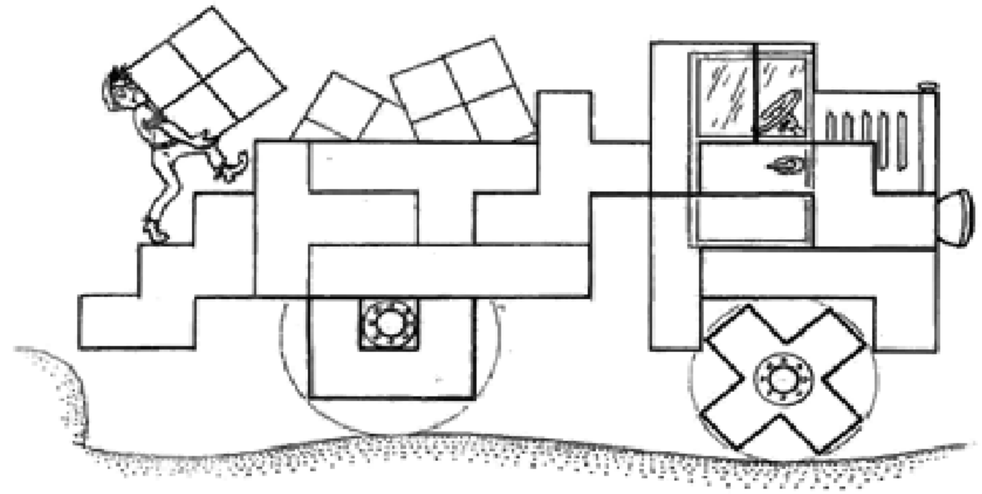
Draw up tables for games with dice B and C, with dice C and D and dice D and A. Which die is the best ? ? ?

Experienced mathematicians might like to look for an alternative numbering with the same effect.

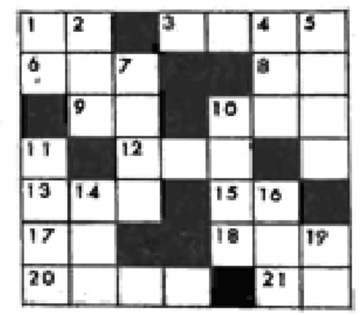
E.G.

A PENTOMINO LORRY

Submitted by M. Bassett, Catford



SENIOR CROSS FIGURE No. 67



Ignore decimal points in solutions and work to the appropriate degree of accuracy. Take π as $3\frac{1}{7}$.

Clues Across

1. Capacity (in ml) of a small cylindrical phial of internal radius 7 mm and length 50 mm.
3. Fourth vertex of kite with vertices (6,16), (3,12) and (8,2).
6. Product of two primes which have a difference of 12.
8. Fifth term in the series 7, 11, 18, 29, ...
9. Gradient of $y=4x^2-16x+15$ when $x=9$.
10. Interior angle (in degrees) of a regular octagon.
12. The length (in m) of a car which has a 50 litre fuel tank if a scale model of length 103.2 mm has a 400 mm^3 tank.
13. p reversed, if $\frac{1}{p}$ is the probability of selecting two Aces from a pack of 52 playing cards.
15. xy, if $4x+5y=47$ and $16x-3y=4$.
17. Reflection of (6,16) in shorter diagonal of kite in 3-across.
18. $(88{\cdot}67)^{\frac{1}{3}}$. (Power).
20. Latitude (in degrees) of B which is on the same meridian and south of A (60°N) if AB=1001 km. Take earth's radius as 6370 km.
21. Coefficient of x^3 in the expansion $(x+1)^6$.

Clues Down

1. Fourth term of a G.P. in which the eleventh term is 9216 and the thirteenth term is 36864.
2. Volume generated (cu. units) when $y=x+2$ is rotated about the x axis between $x=0$ and $x=7$.
4. Gradient of shorter diagonal in 3-across.
5. Product of roots of $4x^2-16x+15=0$.
7. Angle (in degrees and minutes) between longer sides of kite in 3-across.
10. $T_{12} \div T_{11}$ in 8-across.
11. Tan 130°24′.
14. Mean number of digits per clue for this cross figure.
16. Local time difference (in minutes) between the meridians 62°W and 46°E.
19. 710 ÷ 15 (base twelve).

D.I.B.

CURVE STITCHING

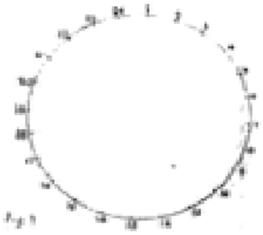


Fig 1

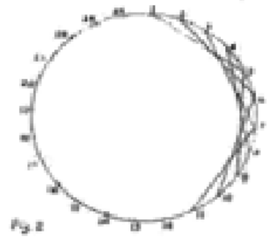


Fig 2

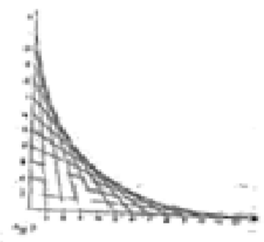


Fig 3

Curve stitching, or Thread Sculpture as it is now more popularly known, is basically simple but, if carefully done, produces an extremely attractive and decorative result. Like many " art " forms it is of a mathematical origin but I do not intend to deal with the mathematical aspects in detail, more with the construction techniques. As the name implies, the basic idea is to join a series of points with thread by stitching. These straight lines, when the design is complete, form the " envelope " of a curve and it is the curve that catches the eye and not the original straight lines.

There are really only two basic shapes upon which to base your designs, namely the circle and the straight line and combinations of them. For the circle a knowledge of modular arithmetic will be assumed and for both types a form of " mapping " will be used but this will be explained. Draw a circle and on it mark and label an even number of equally spaced points, as in Fig. 1. On this figure 24 points are used but the more the better. Join the points according to the rule $1 \to 5$, $2 \to 6$, $3 \to 7$, etc. In terms of a mapping, this can be expressed as $n \to n+4$ where n takes all the values from 1 to 24. When n takes the value 21, the modular arithmetic idea must be used as there is no 25 on the diagram. The pattern brings out the fact that 21 must be joined to 1. Now complete the figure. The " envelope " that we see is really a 24-sided regular polygon but it looks very much like a circle, see Fig. 2.

Another simple rule that leads to an attractive envelope is $n \to 2n$. This is slightly more complicated than $n \to n+4$ but the pattern will help with the modular arithmetic. Now try other rules for the circle—the editor would welcome attractive patterns and will reward the sender if the design is published.

Two straight lines produce one basic shape, a parabola, but the appearance can be changed by varying the angle between the lines. Start with two perpendicular lines and use the usual X, Y notation for the axes. Mark 12 points, equally spaced, on each and join $X_{12} \to Y_1$, $X_{11} \to Y_2$, $X_{10} \to Y_3$, etc., until X_1 is joined to Y_{12} as in Fig. 3. In general if we have N points, the mapping is $X_{N+1-n} \to Y_n$, where n takes the values from 1 to N.

In practice, when continuous thread is used, only some of the gaps between the points are joined as the construction will involve $X_{12} \to Y_1 \to Y_2 \to X_{11} \to X_{10} \to Y_3 \to Y_4 \to X_9$, etc., and your design will appear less complete than a drawing but, I think, attractively so. Consequently the above mapping will have to be modified slightly in that it becomes with thread $X_{N+1-n} \to Y_n \to Y_{n+1} \to X_{N+1-n-1} \to X_{N+1-n-2}$, etc.

continued overleaf

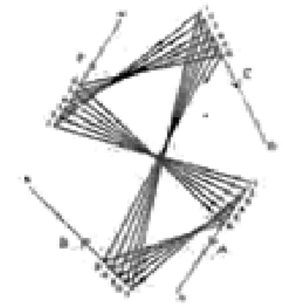


Fig 4

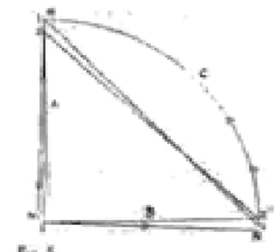


Fig 5