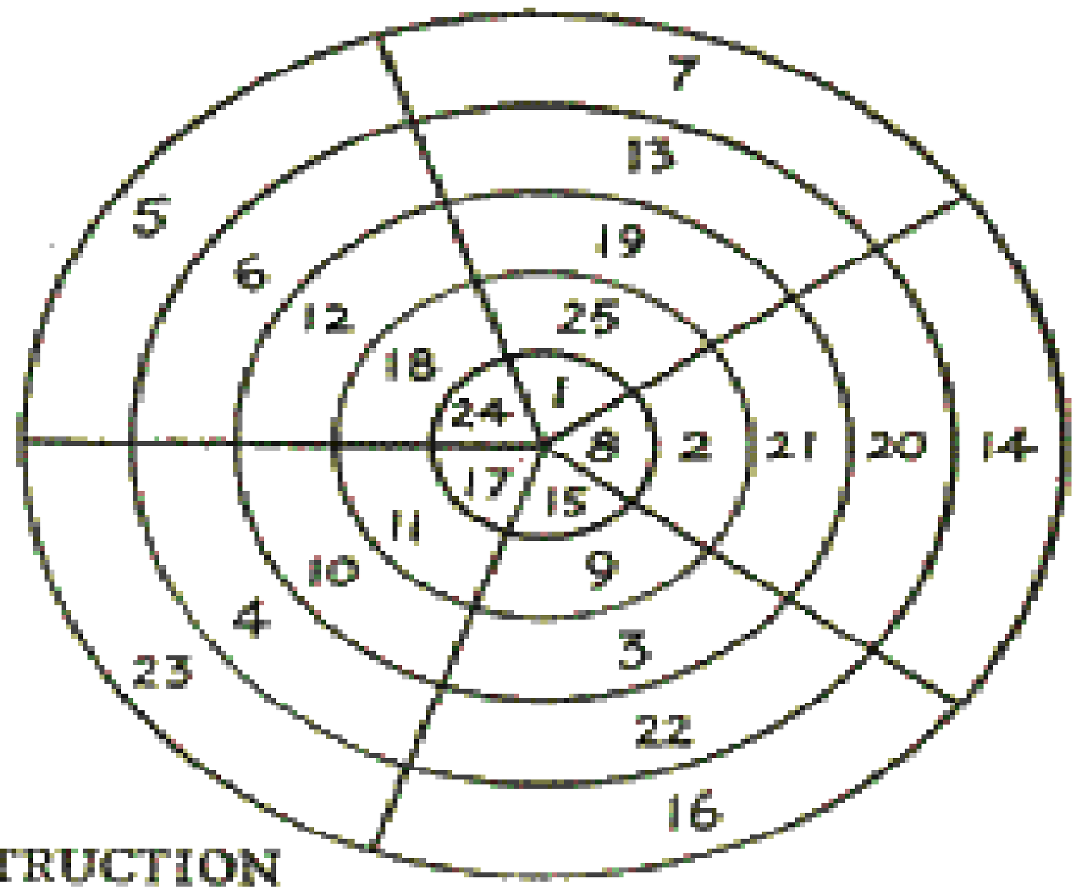
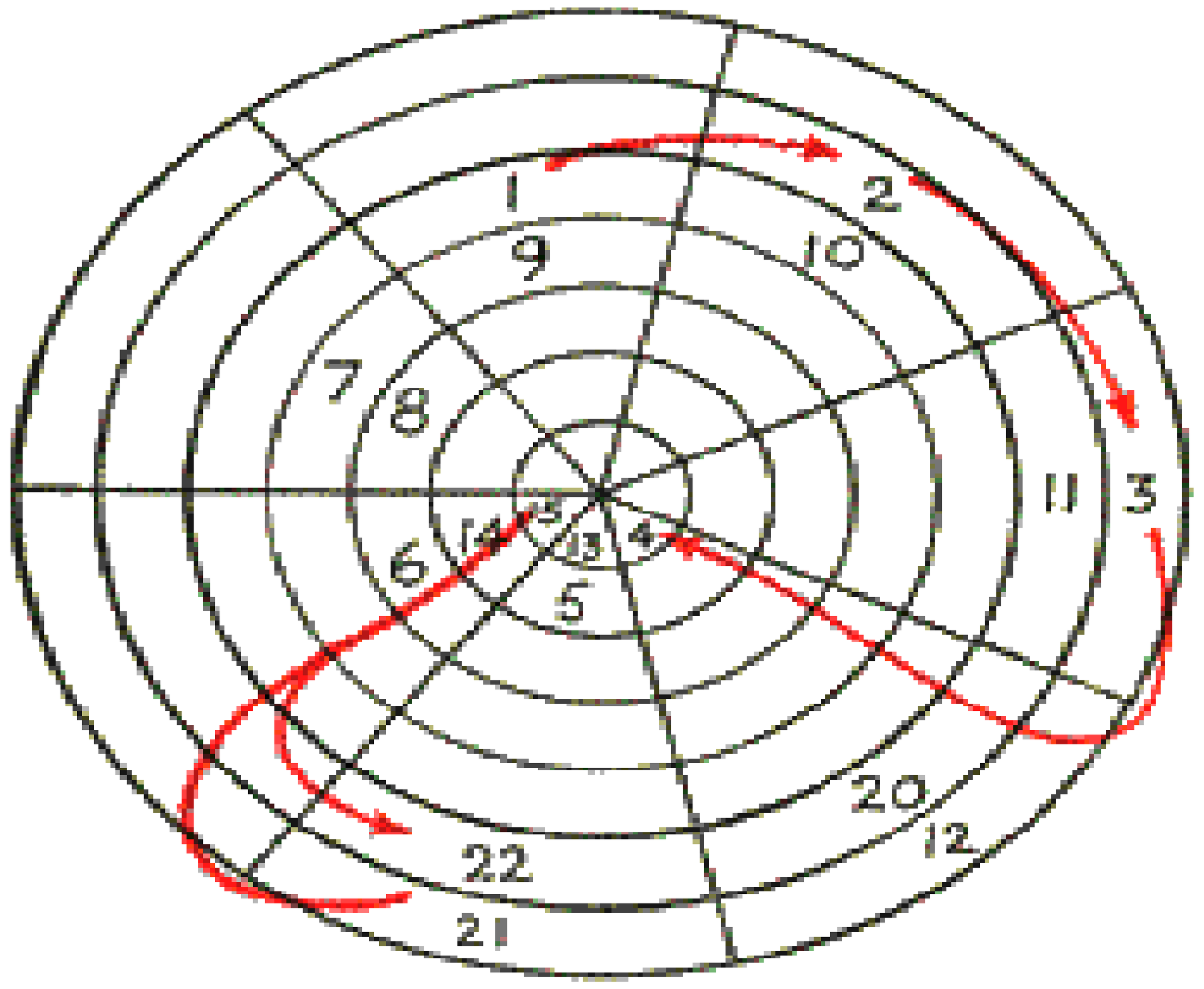
MAGIC CIRCLES

Submitted by Derek Coward, Sheerness Technical High School.



Magic squares are well known, but what about Magic Circles? These may be constructed in a way similar to the squares. One, of order five, is shown on the right. Each sector and each ring has the same total, 65, just like the rows and columns of a magic square. In place of the square's diagonals, the circle has spirals, moving outwards and anti-clockwise, each one totalling 65.

Rules for Construction



1. Draw a circle containing an odd number (greater than three) of sectors, and the same number of rings.
2. Place the number 1 in any "cell."
3. Place consecutive numbers in the cells according to the following rules :—
   (a) Move outwards and clockwise.
   (b) From an outermost cell move to the innermost in the next sector.
   (c) If the next cell is occupied keep to the same sector and move one cell inwards.
   (d) From the innermost, if the next cell is occupied, move to the outermost in the same sector.

Completed magic circles of order 9 and 11 will be shown in the next issue. Now try to complete another magic circle.

AN ANNUAL PROBLEM

In issue No. 53, we asked for ways of using one 1, nine 9's, six 6's, and eight 8's connected by ordinary mathematical symbols to form 1968. The response was overwhelming. A number of solvers were content with a single solution whilst others submitted twenty or more different ones. Some used the digits in any order, others retained the order in 1968, whilst a third set produced symmetrical solutions. The most appealing solution came from Miss S. F. Pack of Salisbury. Book tokens have been sent to the 13 winners.

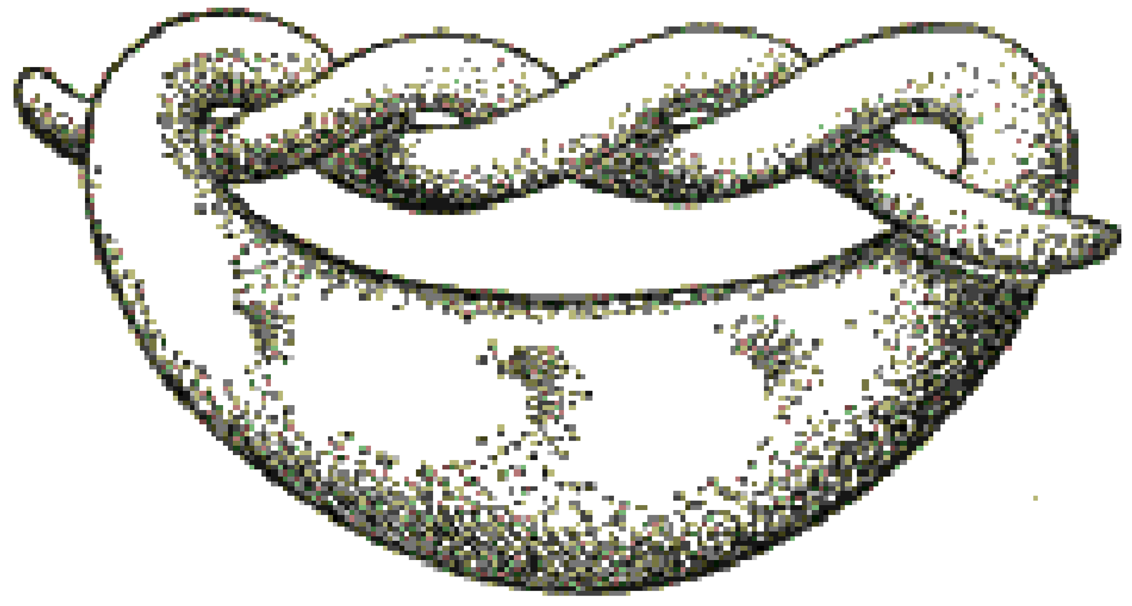
$$\frac{\frac{8}{\sqrt{8}}\left[\frac{\sqrt{9}\left(\frac{9.9.6}{6+6}+\frac{9}{9}+\frac{6.9.9}{6+6}\right)\sqrt{9}}{\sqrt{9}}\right]\frac{8}{\sqrt{8}}}{\frac{8.1.8}{8.8}}$$

B.A.

mathematical pie

No. 55 — Editorial Address : 100, Burman Road, Shirley, Solihull, Warwickshire, England — AUTUMN, 1968

THE AUSTRIAN PRETZEL DISSECTION

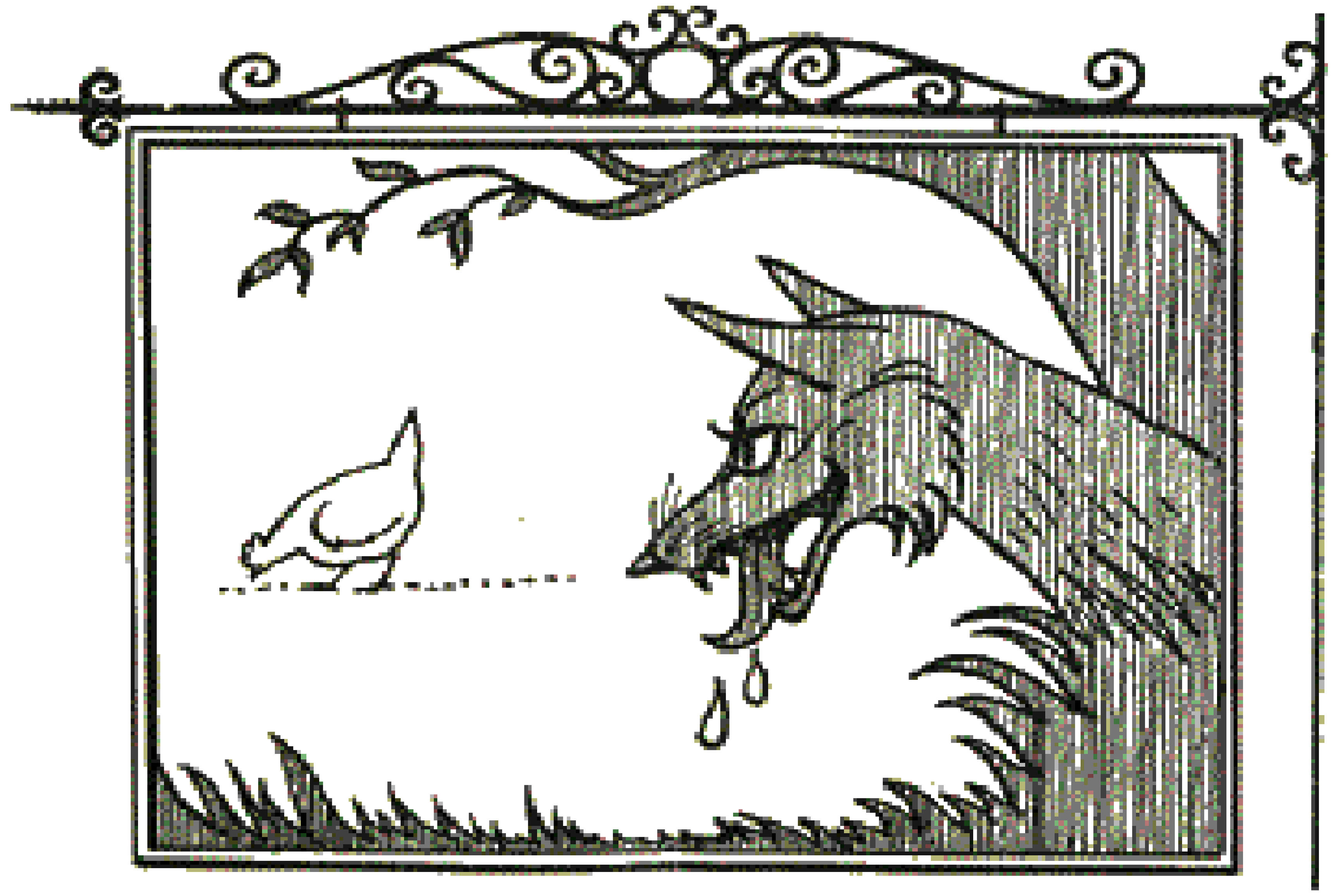


The Austrian Pretzel

The figure shows a twisted Vienna bread roll, called a Pretzel; the twist is purely decorative. What is the greatest number of pieces into which it can be cut by a single blow and in which direction should the cut be made?

MATHEMATICAL INN SIGNS

THE SLY DROOLER was submitted by Deborah Valentine of Amersham; a book token has been sent to Deborah for this contribution. Other Inn signs have been submitted and will be published in future issues.



DO NOT FORGET

Submitted by Paul Stacey, County Secondary School for Boys, Corsham.

Plot the points whose co-ordinates are given and join by straight lines using a scale of 1 inch for ten units on each axis.

(a) 0,72: 6,73: 17,79: 22,77: 25,69: 22,59: 11,52: 13,64: 10,70: 6,73.
(b) 10,70: 16,75: 22,77. (c) 5,63: 8,67: 12,66.
(d) Draw a circle radius 1 unit, centre 9,64.
(e) 10,57: 11,54: 8,51: 5,57: 3,48: 9,42: 12,39: 20,39: 23,33: 21,30: 20,31: 19,30: 20,33: 18,36: 9,36: −3,48: −5,57: −8,51: −11,54: −10,57.
(f) 11,52: 12,39. (g) 12,36: 11,22: 10,23: 10,36.
(h) 9,42: 8,51. (i) 7,53: 4,51.
(j) 1,44: 0,43: −2,44: −2,47. (k) 11,52: 15,46: 16,39.
(l) 15,36: 13,33: 11,15: 12,5: 5,5: 5,21: 0,26.
(m) 3,22: 3,11: 5,11. (n) 5,5: 6,6: 7,5: 8,6: 9,5: 10,6: 11,5: 12,6.

Repeat all except (e) and (j) with negative values of x and join 10,36 to 9,42 ; 12,39 to 13,36 and 16,39 to 15,36.

The whole area may be shaded as appropriate.

REVERSIBLE SQUARES

Submitted by Mr. A. Osbaldiston, Kidderminster.

$13^2 = 169$, reversing the order of the digits gives $31^2 = 961$. Find other numbers with the same property and try to generalise the result.

THE INVERSE OF π

Submitted by Mr. J. Magee, Malet Lambert High School, Hull.

CAN I DISCOVER THE RECIPROCAL of π?

Counting the letters of the words gives 3 1 8 3 10 which gives the value correct to 6 significant figures.

PYTHAGORAS BY SLIDE RULE

Submitted by Mr. B. N. Borty.

Good slide rules have all trigonometrical ratios on them making tables unnecessary. Engineers and electricians sometimes encounter problems involving "Pythagoras" and use their slide rules to solve them.

Consider the triangle with a right angle and the two sides about the right angle 3 units and 4 units. It is a well-known fact that the hypotenuse will be 5 units. The slide rule method for solving this problem is :—

Let the hypotenuse be x units. Then

$$x^2 = 3^2 + 4^2 \qquad \text{(Theorem of Pythagoras)}$$

Then $$\left(\tfrac{x}{3}\right)^2 = 1^2 + \left(\tfrac{4}{3}\right)^2$$

and $$\tfrac{x}{3} = \sqrt{\left(1 + \left(\tfrac{4}{3}\right)^2\right)}$$

Using the slide rule, find $\frac{4}{3}$ from scales A and B. It is 1·333. With the cursor, find the square of this on scale D, it is 1·778. Add 1 to 1·778 in your head, the result is 2·778. Move the cursor to 2·778 on scale D and find $\sqrt{2{\cdot}778}$ on scale A, it is 1·667. Now multiply 1·667 by 3 to find x using scales A and B. The answer is 5.

A word of caution is required, be careful with the position of the decimal point when adding the 1 mentally. If the hypotenuse is given, the method requires the 1 to be subtracted as you can easily show.

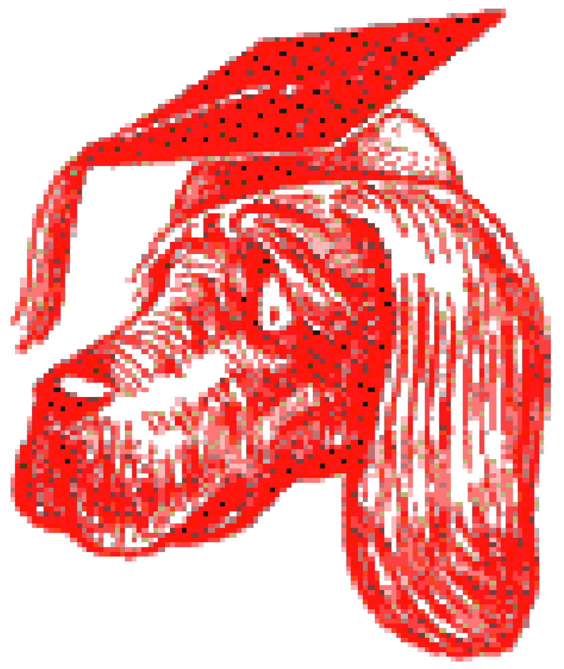
Now try these : find the hypotenuse of a right angled triangle if the other two sides are 28 and 45 units respectively. Find the other side if the hypotenuse is 31·4 and another side is 26·4 units, and find the third side of the right-angled triangle whose hypotenuse is 34 units and one other side is 14·4 units.

THE STUDENT'S COMPLAINT

Submitted by Mr. R. M. Helsdon, Poole.

In maths at school we learn of sets
And sets and sets and sets and sets.
Sets of cats and sets of dogs,
Sets of cows and sets of hogs,
Sets of cabbages and kings,
And sets of unrelated things.
Just what these sets are all about
Is something I can't fathom out!
Geometry is sets again,
For all are sets : point, line and plane.
By affine transformations we
Learn all about geometry.
Translations and inversions too,
Our teacher shows us how to do.
But when from class we all come out
We wonder what its all about!
We also learn the queerest tables
Stranger than old Aesop's fables.
Two fours, base three, is twenty-two
Which may sound very odd to you ;
And seven times two, mod. five, is four ;
Which may surprise you even more.
These endless tables tax my brain
But all my protests are in vain!

My little brother's not so dim,
Figures were always fun to him.



But now with coloured blocks he's taught,
All his efforts come to naught.
Why should this be ? Alas we find
The child was always colour blind!

When through topology we skip
We learn about the Mobius strip
Klein's bottle and the bridges seven
In Konigsberg. But why in heaven
Are doughnuts classified the same
As loop of string or picture frame ?
Is all this odd topology
Required in our Technology ?
New maths breeds symbols by the score,
Topics proliferate more and more.
Linear programs, magic squares
And matrices and ordered pairs,
Transformations, isomorphic groups,
The Eigen vector, one plane loops,
Boolean logic, inequations,
Continued fractions and translations,
Computers and Diags. of Venn,
And scales to every base but ten.
The number systems of the Greeks
Romans, Egyptians and the Cretes,
"Funny" pictures and feeble jokes,
Fragments of verse and off-beat quotes
And puzzle-corner maths and tricks
With folded paper or match sticks.

Gimmicks and novelties galore
From out the printing presses pour
But why NEW MATHS I'd like to know
Since it was written years ago
By Boole and Carey and John Venn
And many other famous men
Who from earth had all departed
Ere technology had started!

By R. M. and C. W. Helsdon.

SOLUTIONS TO PROBLEMS IN ISSUE No. 54

SENIOR CROSS FIGURE No. 50
Clues Across : 1. 12 ; 3. 4143 ; 7. 676 ; 9. 370 ; 10. 4458 ; 13. 5203 ; 16. 222 ; 17. 453 ; 19. 8455 ; 20. 25.
Clues Down : 1. 1667 ; 2. 27 ; 4. 135 ; 5. 478 ; 6. 30 ; 8. 64 ; 11. 440 ; 12. 1935 ; 13. 524 ; 14. 225 ; 15. 34 ; 16. 28 ; 18. 52.

FIND THE NUMBER
Card 1 should have had 3 instead of 2 as the second figure on the first line.

SOLUTIONS TO PROBLEMS IN ISSUE No. 55

THE INVERSE OF π — See also MME new volume 1, page 345.
THE STUDENT'S COMPLAINT — The diagram shows a red setter !

B.A.

Continued from page 433

(iv) Threaded with cotton, each of the remaining 12 straw lengths should be connected from a vertex to the centre of the model.

The sixty indented faces (equilateral triangles) of the completed model meet at the centre. Thus the volume of the " solid " is zero.

Diagram No. 2 represents the net of equilateral triangles from which the model can be constructed in cartridge paper. All lines should be scored with a blunt edge and the broken lines indicate reverse folding. Assemble the centre band before the upper and lower faces, using a quick drying adhesive cement.

A little elementary geometrical thought or experiment is bound to bring cries of " Cannot be done! " at the suggestion of a cube with indented equilateral triangular faces. Nevertheless, it is possible to represent the intersecting planes through the medium of paper and glue. Diagram No. 3 is a net forming the main part of the model. Broken lines again indicate reverse folding. The flaps and faces are numbered to assist assembly. Diagram No. 4 is the net of the apex of each pyramid formed by the intersection of four triangular faces. Six of these pyramids are required and, when fixed in position on the main part, the model is complete.

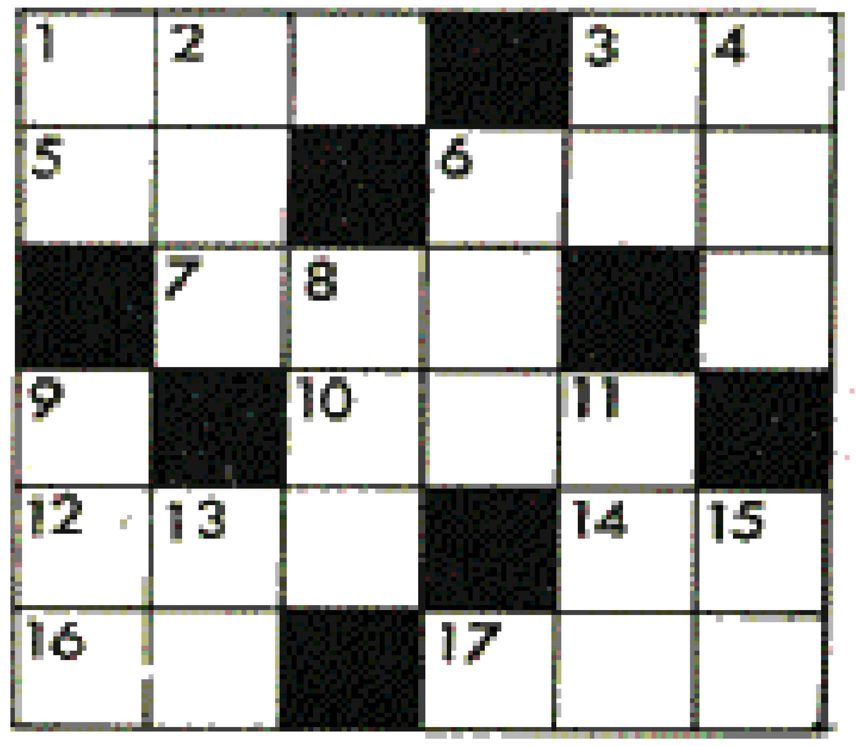
The apparent indented triangles of each square face of the cube do not form the triangular indents of that face. In fact, they form part of the reverse side of one triangular indent for each of the four adjacent square faces : the four meeting lines of the apparent indented triangles are formed by the intersection of the equilateral triangles. The apex of the pyramid from the opposite face interpenetrates the four intersecting planes where they meet.

A negative volume can simply be calculated showing that the ratio of the solid cube to the neglid is $1 : \sqrt{2}$.

The calculation of the dimensions for the net of this model provides a worthwhile geometrical and trigonometrical exercise.

D.I.B.

JUNIOR CROSS FIGURE No. 48



Across

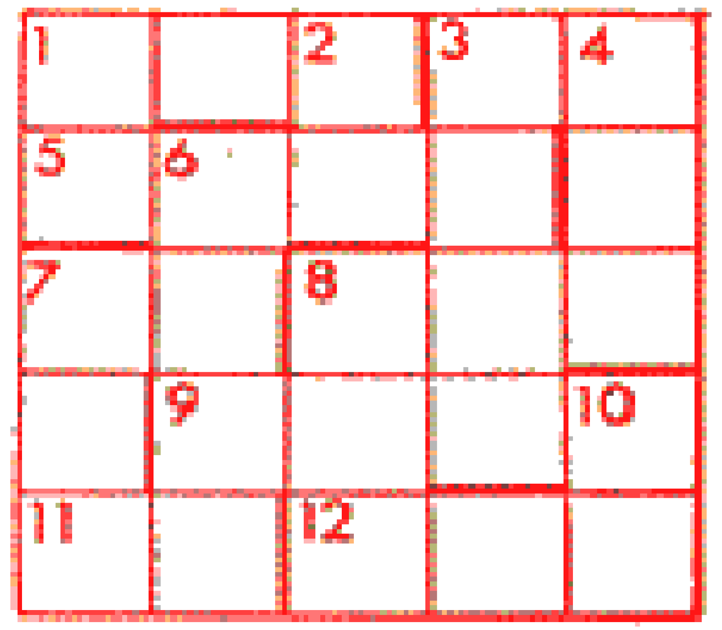
1. An unlucky square for some!
3. Area, in sq. units, of parallelogram in 5–across.
5. Fourth vertex of parallelogram with vertices (0,0), (2,3), (7,4).
6. Change 12000 (base–three) into base–ten.
7. 2210 – 1221 (base–three).
10. 10032 ÷ 12 (base–four).
12. 135 m.p.h. in ft. per sec.
14. Diameter of a cycle wheel which turns 720 times in 1 mile, in inches.
16. Average number of digits per clue for this crossfigure.
17. Centimetres in 1 inch.

Down

1. $\{\text{Multiples of 3 between 0 and 30}\} \cap \{\text{Multiples of 5 between 0 and 30}\} \cap$
2. Total number of possibilities reversed when 3 dice are thrown together.
3. Area of square on the shorter side of parallelogram in 5–across.
4. Point of intersection (ordered pair) of diagonals in 5–across.
6. Reflection of (0,9) in the line $y = 2x - 6$.
8. $\sqrt{(2^{29} \div 2^{15})}$.
9. Value of x when $\log_2 x = 8$.
11. Volume of a cube of which the total surface area is 150 sq. units.
13. Unequal angle of a convex pentagon which has four angles each of 111°.
15. $8\frac{3}{4}$% of this number is 7. D.I.B.

FOR LEFT-HANDED NUT CRACKERS !

This unusual binary crossfigure was submitted by Mr. D. B. Smoldon, of Barnstaple.



Clues Across

1. 3 down – 6 down.
3. 0011 – 0101.
5. 12 across + 7 down.
7. 0111 – 0011.
8. 7 across × 11 across.
9. 11 across^2 + 2 down.
11. 01001 ÷ 011.
12. 00111 ÷ 001.

Clues Down

1. 11 – 1.
2. 0011 ÷ 001.
3. 11011 – 1011.
4. 7 across + 11 across.
6. 4 down × 3 across.
7. 2 down × 7 across.
8. 0011 ÷ 11.
10. 5 across – 6 down.

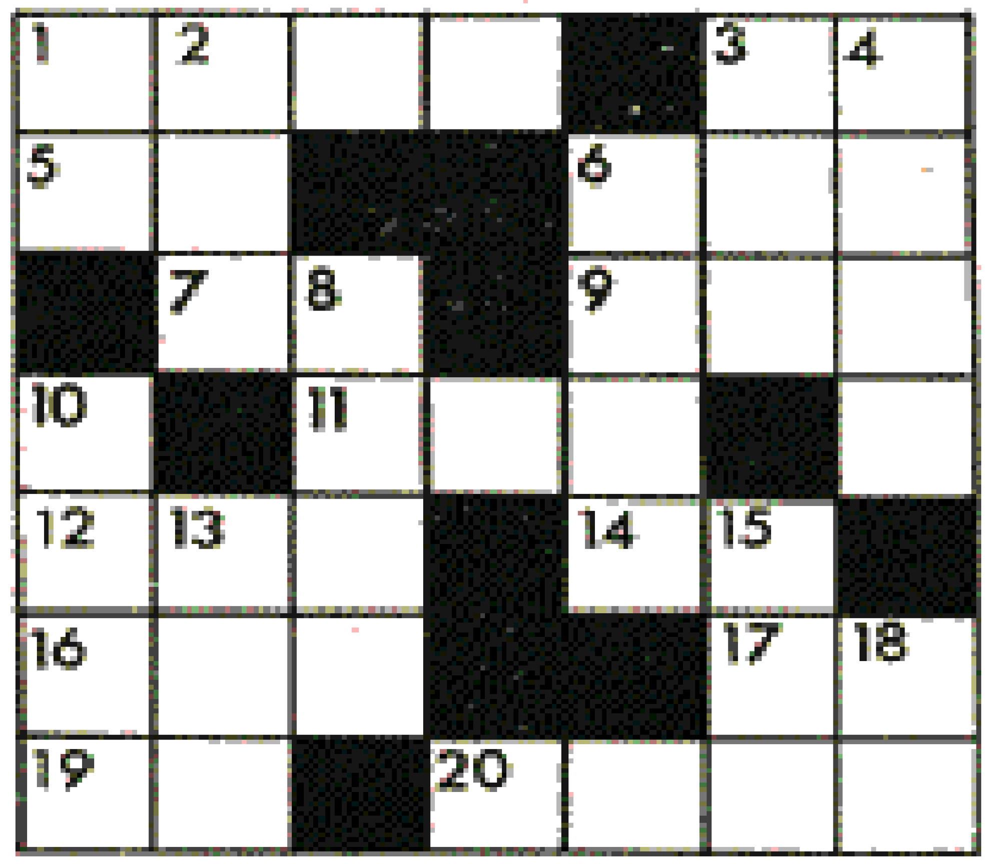
999 ; POLICE !

By using elementary symbols such as , –, x, ÷, and √ can you make the following numbers from 999 ?

a. 1. b. 2. c. 3. d. 4. e. 9.

SENIOR CROSS FIGURE No. 51

Ignore decimal points and give each solution to the appropriate number of figures. $\pi = 3\frac{1}{7}$



Clues Across

1. $8\frac{1}{3}$ in base-three.
3. The sum (in £) which, when increased by $37\frac{1}{2}$%, becomes £104 10s. 0d.
5. Solve, giving x first :
   $279x + 721y = 7163$
   $721x + 279y = 5837$
6. Sum, to nine terms, of series : –98, –96, –92, –84, ...
7. $\frac{1}{2^{-6}}$.
9. Volume generated when $7y = 6x$ is rotated about the y axis between $y = 0$ and $y = 6$.
11. Find n when $\log_2 n = 4{\cdot}51$.
12. If $p \propto q^2$ and $p = 36$ when $q = 2$, find p when $q = 5$.
14. The principal which yields £73 4s. 0d. simple interest at a rate of $7\frac{5}{8}$% per annum for 15 years.
16. Total window area (sq. ft.) of house in 1–down if that of model is 24 sq. in.
17. Radius of a circle to which, from an external point 10·5 in. from the centre, a tangent is 8.4 in. long.
19. Product of roots of :
   $x(5x - 24) = -27$.
20. Tan.239°12′.

Clues Down

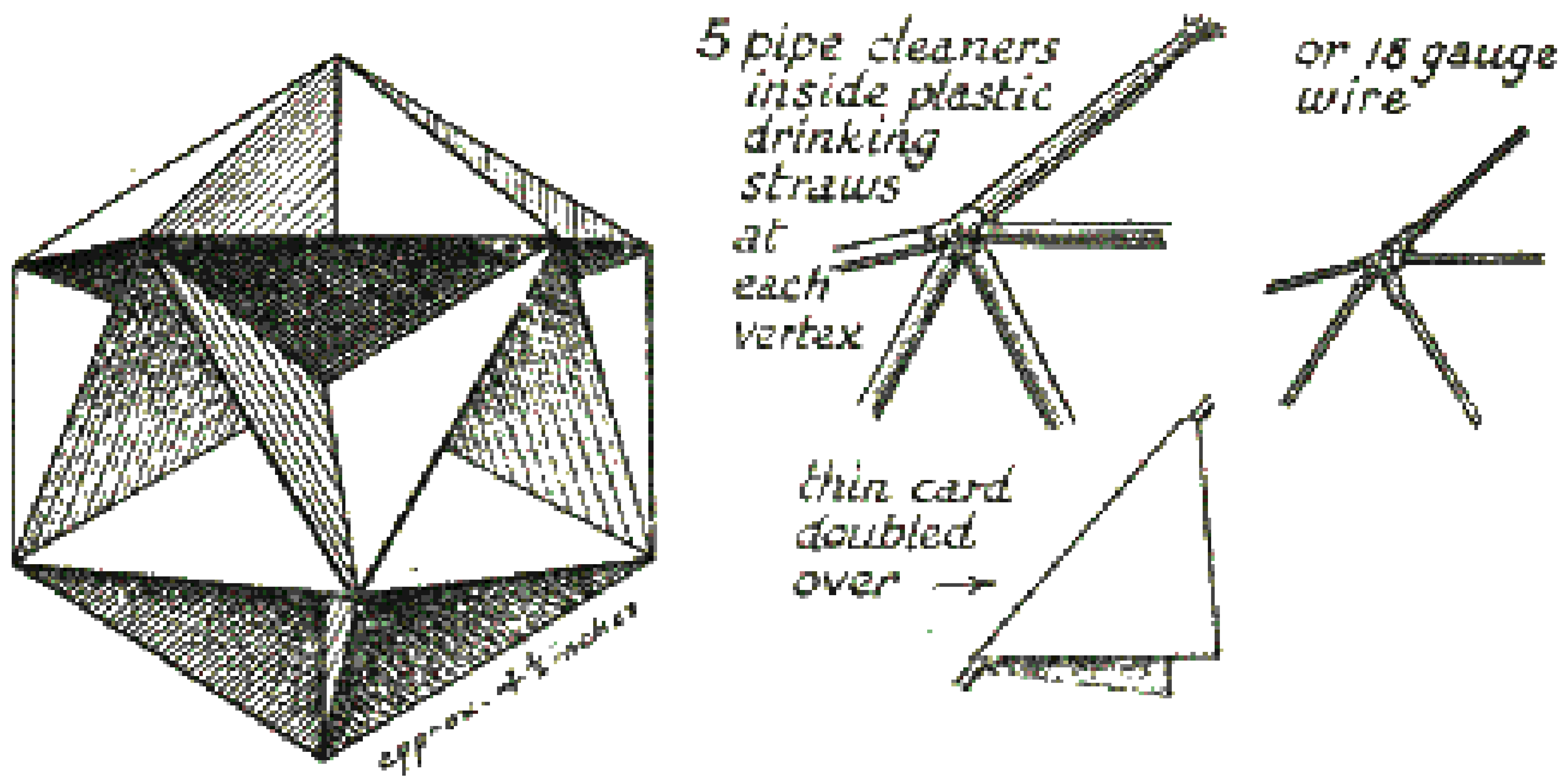
1. Width (in ft.) of a house with a frontage of 40 ft. if the scale model has width and frontage of 5 in. and 8 in. respectively.
2. Shortest surface distance in miles between two points on the same meridian with a difference of 4·14° latitude. (Earth's radius = 3960 ml.).
3. Sum of the interior angles of a convex hexagon.
4. Cos.308°54′.
6. Smallest possible surface area (sq. cm.) to completely enclose 4851 cu. cm.
8. Volume of loft in 1–down if that of model is 34 cu. in.
10. Minimum value (reversed) of y in the equation :
   $y = 4x^2 - 3x$
13. If $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$, find u when $f = 51$ and $v = 68$.
15. Distance (in ml.) of start from finish for :
   30ml. 070° + 23ml. 013°
18. Sum to 19 terms of :
   $-1, -\frac{2}{3}, -\frac{1}{3}, 0,$ . . . .

D.I.B.

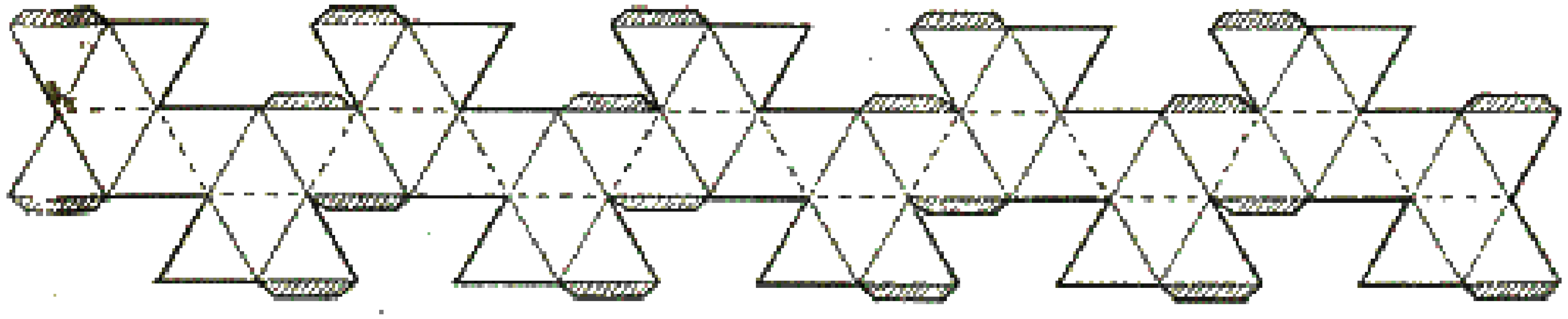
NOLIDS AND NEGLIDS

Indented Icosahedron

DIA. 1



DIA. 2



Net for model with sides from 1½ inches upwards.

Having constructed a four-dimensional representation of a cube (Issue No. 51), one is unlikely to express much surprise at the possible construction of " solids " with zero or even negative volumes. These structures we shall term as nolids and neglids, respectively.

As an example of a nolid, a regular indented icosahedron has been chosen. Unaware of the existence of nolids, some members of a secondary modern school maths club accidently discovered this example when adding struts to a straw model of an icosahedron.

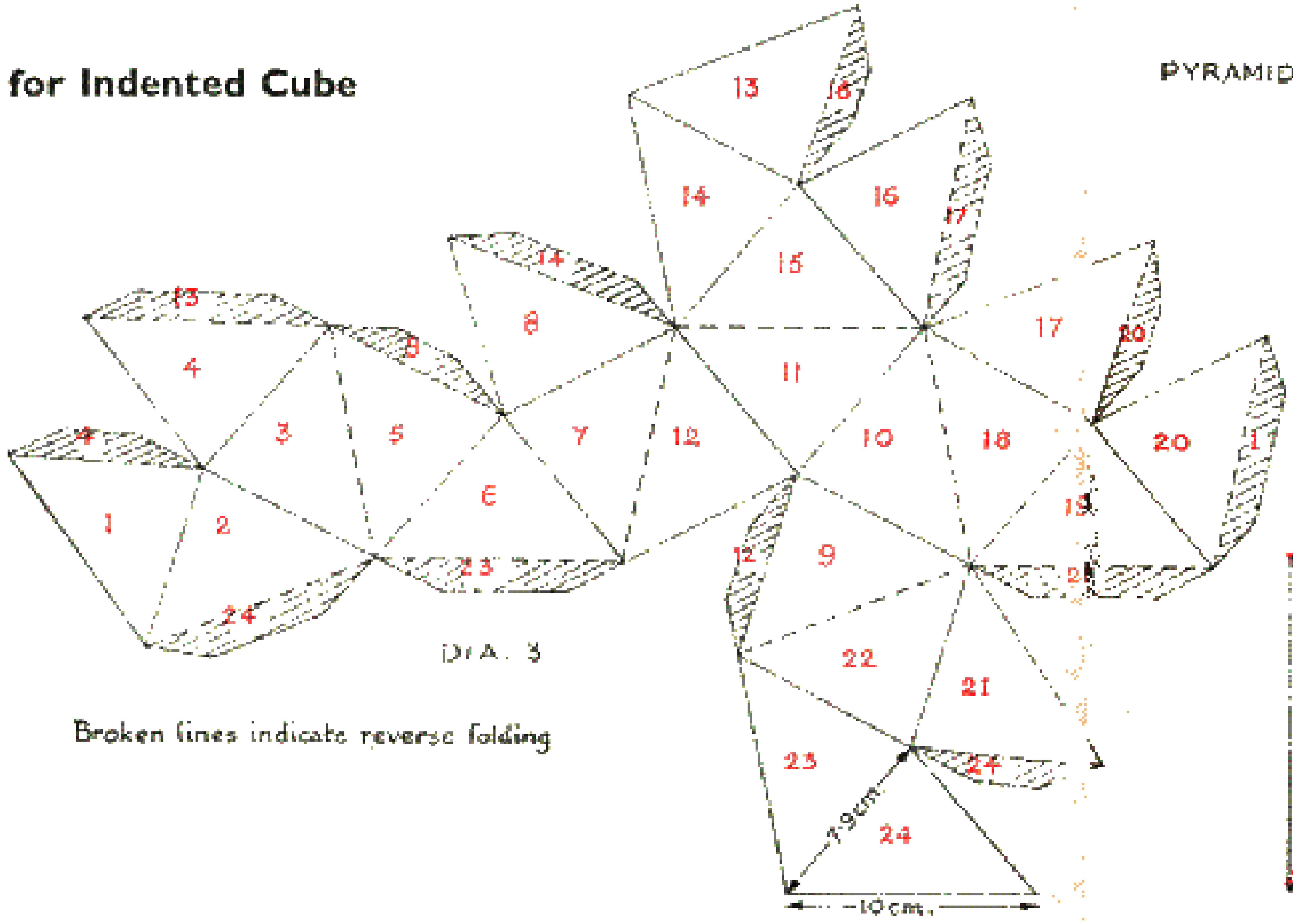
(i) Cut 42 equal lengths from plastic drinking straws and form 12 five-armed vertex supports from pipe-cleaners.

(ii) With 3 vertex supports and 3 straw lengths, construct an equilateral triangle as a base.

(iii) Gradually build up the icosahedron from this base, with 30 straw lengths as edges.

Continued on page 434

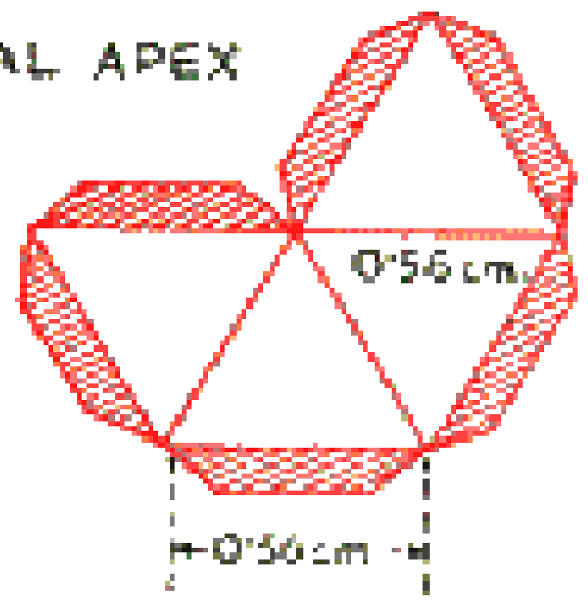
Net for Indented Cube



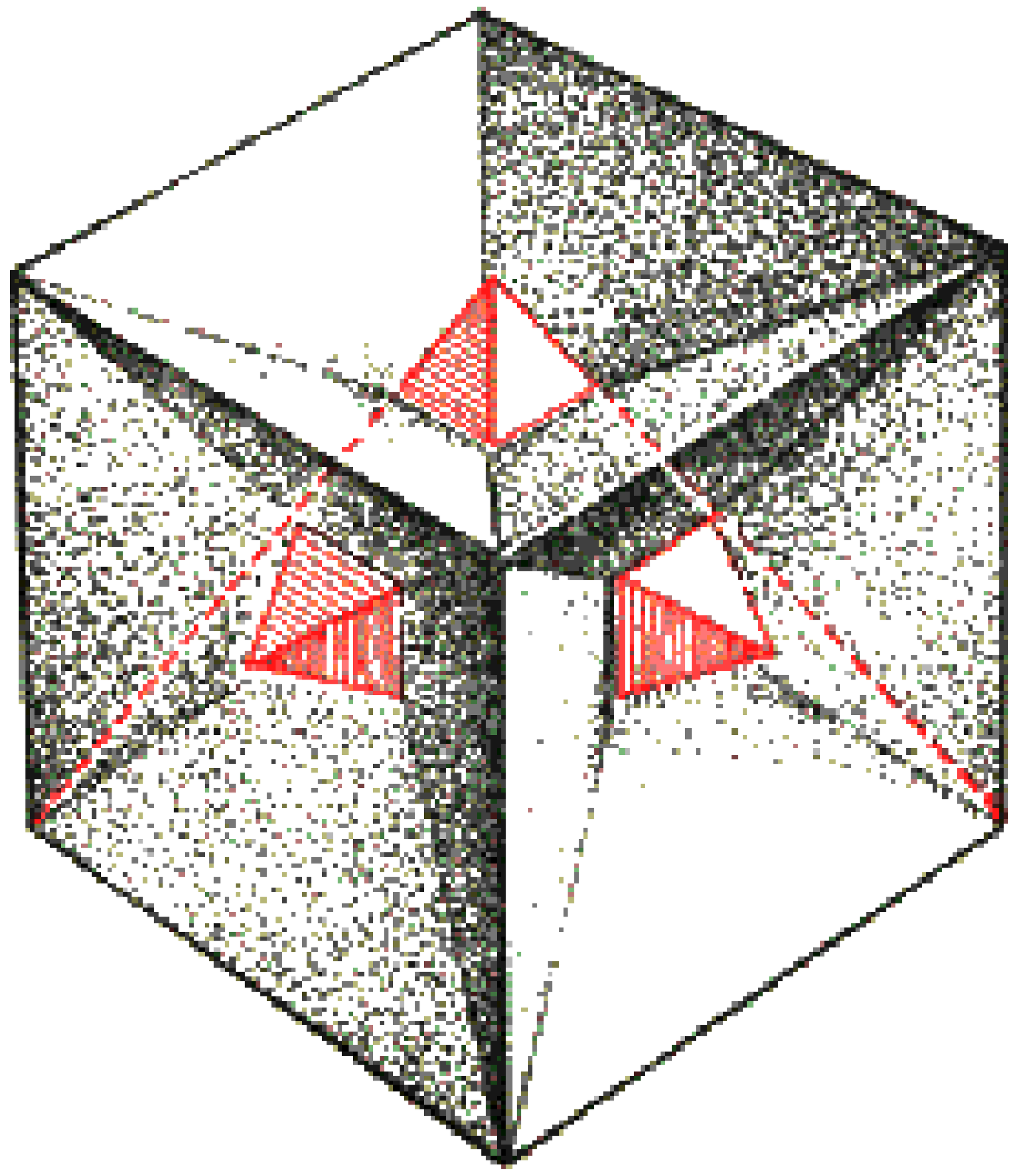
DIA. 3

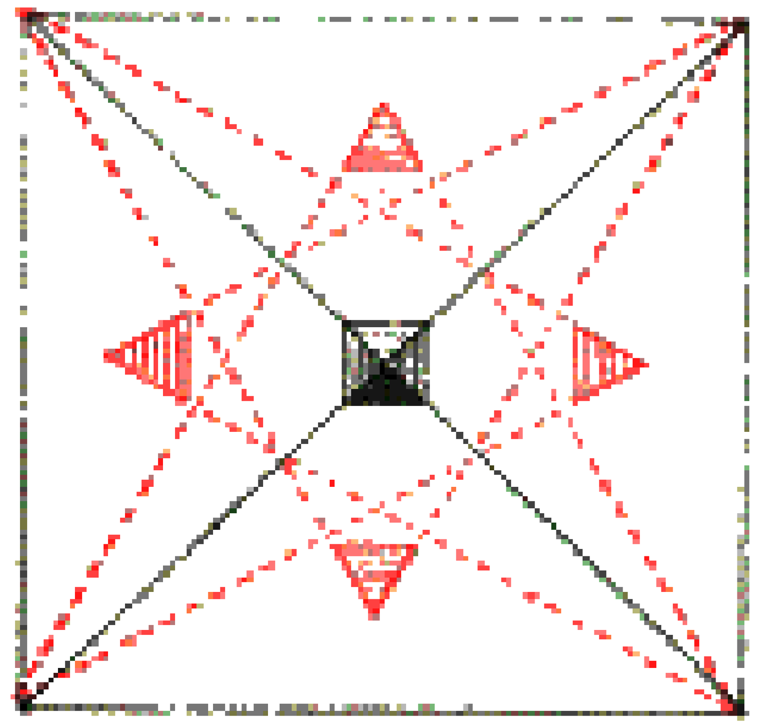
Broken lines indicate reverse folding

PYRAMIDAL APEX



DIA. 4





PLAN OF INDENTED CUBE.
HIDDEN DETAIL IN COLOUR;
APICES SHADED.