Method: (i) Work out $\frac{b}{a}$ and $\frac{c}{b}$, in this case 3·50 and 0·43.

(ii) Lay a ruler (or, better still, a strip of perspex with a line cut in its surface) across from 3·5 on the left hand scale to 0·43 on the right hand scale, as shown in the small figure on the left, and read off the numerical values of the roots given by the intersections of the ruler with the curved scale.

(iii) Attach to these values the sign opposite to the sign of b.

In this example, the roots are +3 and +0·5.

Case II. $ax^2 \pm bx - c = 0$, where a, b and c are positive numbers.

Example: $2x^2 - 5x - 3 = 0$

Method: (i) Work out $\frac{b}{a}$, $\frac{c}{a}$ and $\frac{c}{b}$, in this case 2·5, 1·5 and 0·6.

(ii) Lay a ruler across from the reading 2·5 on the left hand scale to the reading 1·5 on the base, as shown in the small figure on the right, and read off the value of the numerically larger root from the intersection with the curved scale.

(iii) Lay the ruler across from the reading 0·6 on the right hand scale to the reading 1·5 on the base, and read off the value of the numerically smaller root.

(iv) Attach the sign of b to the numerically smaller root, and the opposite sign to the numerically larger root.

In this example, the roots are +3 and —0·5.

Caution. As the scales are not uniform, the subdivisions have different meanings at different parts of the scales. C.V.G.

MATHEMATICAL LIMERICK, No. 5

Contributed by R. T. McLaughlin, Sherborne School.

There was an old man called Peard,
Who thought of the length of his beard,
Which he doubled and then
Added its square minus ten,
Which was minus two feet—very weird.
What was the length of his beard?

SOLUTIONS TO PROBLEMS IN ISSUE No. 19

MARTIAN MATHEMATICS.

(a) Answer to the last Martian sum is 11.

(b)

Earth numbers:	0	1	2	3	4	5	6	7	8	9
Martian ..	8	3	7	4	5	9	0	2	6	1

POLES APART.

C is 6 ft. 8 ins. above the ground.

SENIOR CROSS-FIGURE No. 19.

Across: (2) 21·8 sq. cms.; (5) 4368; (7) 30°; (8) 3·83; (10) 104°; (12) ·446; (13) 231; (15) 55°; (16) 989·8; (19) 35·6.
Down: (1) 34; (2) 26; (3) —1·83; (4) 90 sq. cms.; (6) 380·25; (7) 3·3489; (9) 8·4; (11) ±43; (14) 19·5 cm; (15) 52; (17) 85; (18) 81.

FALLACY No. 19.

The hotel manager seems to have forgotten about the tenth guest.

CAN AL HAVE AN ANSWER.

When loaded, the barge settles lower in the water, the level of which rises slightly over the whole connected system. The extra load on the bridge is thus small and independent of barge position. If the load drops, its immersed weight will be about $21\frac{1}{4}$ tons, which the bridge can just stand.

JUNIOR CROSS-FIGURE No. 17.

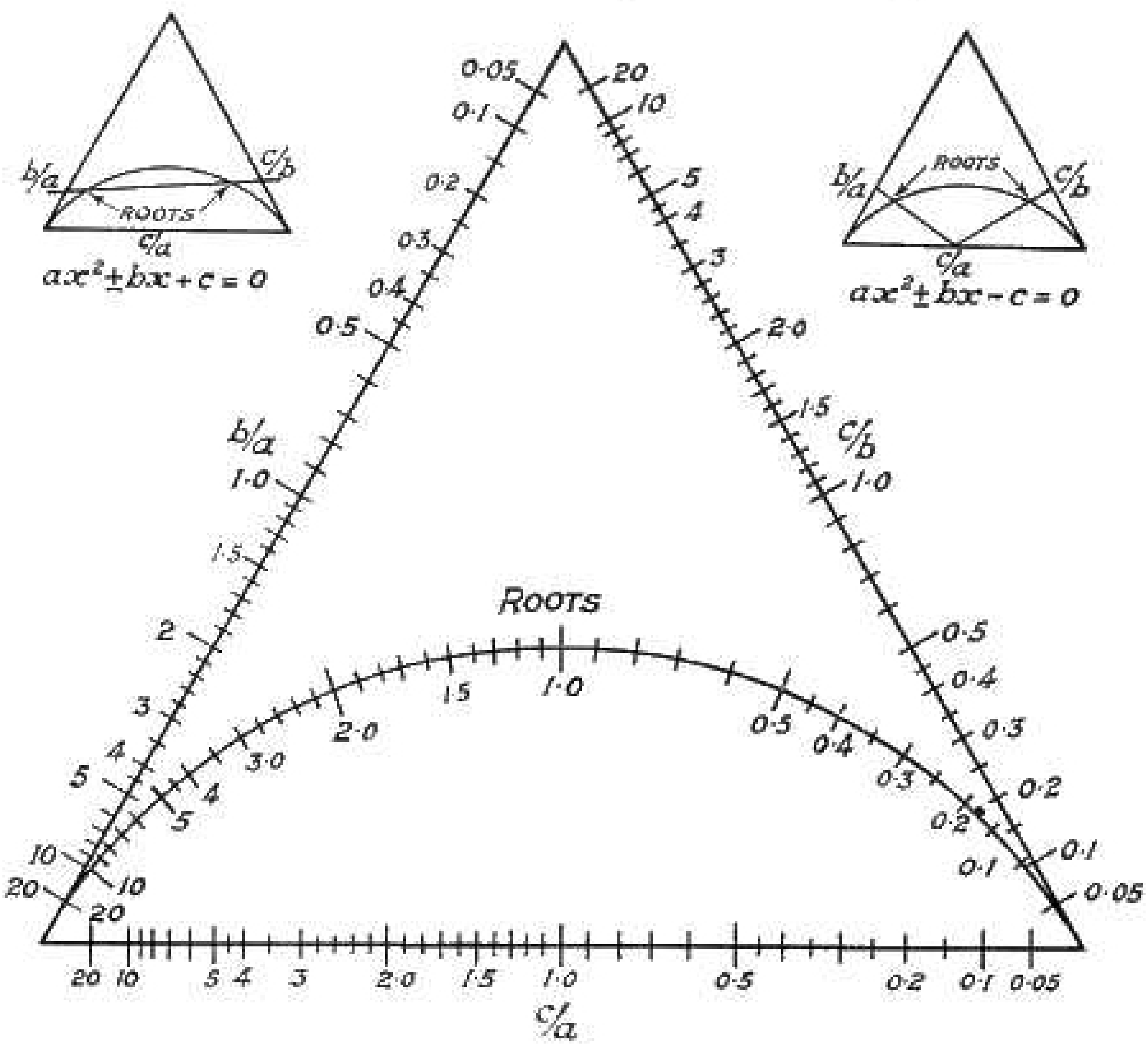
Across: (2) 140°; (4) 61 sq. cm.; (6) £62; (7) 65; (9) ·13; (10) 348.
Down: (1) 16·6; (3) 4761; (5) 1224; (8) 533. I.L.C.

11595 62863 88235 37875 93751 95778 18577 80532

MATHEMATICAL PIE

NUMBER TWENTY *Editorial Offices:* 97 Chequer Road, Doncaster. FEBRUARY 1957

THE EASY WAY TO SOLVE QUADRATIC EQUATIONS



Engineers always avoid arithmetic, when they can, by using a slide rule or a nomogram. The figure above is a nomogram for the solution of quadratic equations. When we solve a quadratic equation by the formula, the standard equation is taken as $ax^2 + bx + c = 0$, where a, b, c stand for numbers which may be positive or negative. To make the nomogram simpler, it has been drawn with positive scales only; this means that we have to treat equations differently according to the sign of the constant term.

Case I. $ax^2 \pm bx + c = 0$, where a, b and c are positive numbers.

Example: $2x^2 - 7x + 3 = 0$

This article is concluded on the back page. Open out your copy so that you have both front and back pages visible at the same time.

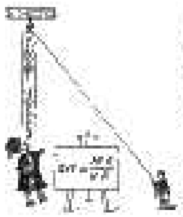
73637 17872 14684 40901 22495 34301 46549 58537

CURIOUS DIVISION

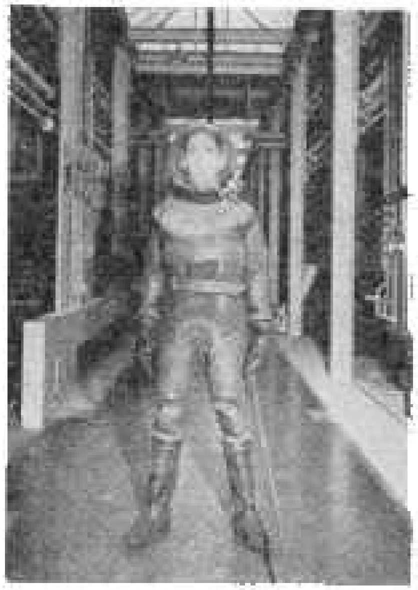
$$\frac{111111111111111111}{9} = 12345679012345679$$

The above is the sort of unexpected result which turns up when you start playing with a calculating machine. Why is there no figure 8 in the answer? R.H.C.

I WANT TO BE—No. 3—A PHYSICIST



The study of pure mathematics is perhaps one of the most satisfying intellectual pursuits, even allowing for the truth of Bertrand Russell's contention that "mathematics is the science in which we do not know what we are talking about, and do not care whether what we say about it is true."



Frog suit for cleaning radio active cells. Reproduced by permission of Ministry of Supply.

Mathematics, however, plays a very important part in the structure of the other sciences. This remark is particularly true in respect of physics, a science in which mathematics can be said to bind the structure together, just as the mortar holds the bricks in a wall.

Without mathematics, there would be a possibility of physics becoming mainly a science of recording observations, with little in the way of prophecy and creative work. As it is, however, mathematics performs for the physicist the following three important functions (among others):

1. It provides theorems, theories such as the Theory of Equations and many other mathematical tools to help in developing the subject. (Try, for example, to work out the action of one bar magnet on another without using mathematical expressions.)
2. It provides the means for computing the results of experiments, and expressing them in a form which is readily appreciated.
3. It helps in discovering new phenomena.

Physics, therefore, is a science in which the mathematician can find plenty of scope and exercise for his or her talents. Apart, however, from the mathematical appeal, physics offers many diverse attractions to the modern youngster. It is possible, in fact, that physics is moving forward at the present time at a greater rate than any other of the sciences.

There is a wide choice of posts open to the qualified physicist, for example, every major industry nowadays has a central research organisation, to which problems are referred by member firms, while, at the same time, long term research projects are also undertaken. Practically every one of these organisations has a physics department because, no matter whether the product is coal, metals, food or packing materials, there are always problems in connection with these products which are in the province of the physicist.

Take coal as an example: school physics experiments would give a lead on determining the density of a sample of coal and its specific heat, but not much more. In industry, however, coal is often ground into a

CHARLIE COOK No. 7

Contributed by Mr. H. B. Talbot, M.A., Sevenoaks School, Kent.

$$(2-x)(x+3) = 4$$
$$\therefore (2-x) = 4, \text{ or } (x+3) = 4$$
$$\therefore \quad x = -2 \text{ or } \quad x = 1$$

VI formers might investigate what other equations of form $(a-x)(x+b) = c$ could be correctly solved by this incorrect method.

LETTERS TO THE EDITOR. No. 3

Dear Sir,

Through my school years, and now in my college years, I have been, and am, an ardent reader of your excellent paper. It was, therefore, with horror that I read in your edition No. 18 the following out-dated statement: "$2^{127}-1$ is, in this year of grace, the largest known prime number." I feel that I must inform D. J. Chittenden that, since 1952, a relatively large number of higher primes, in various forms, have been discovered. The details may be found in various mathematical gazettes. In particular, however, 2^n-1 has been found prime for n = 521, 607, 1279, 2203, 2281, giving 5 more perfect numbers. (Viz. "Proceedings of American Math. Soc., Vol. 5, No. 5, Oct. 1954," an article on "Mersenne and Fermat Numbers" by R. M. Robinson.)

Incidentally, the author of your article did not make clear the following theorem: "An even number is perfect if, and only if, it is the form $2^{n-1}(2^n-1)$ where 2^n-1 is prime."

Thank you in anticipation for your tolerance in reading this.

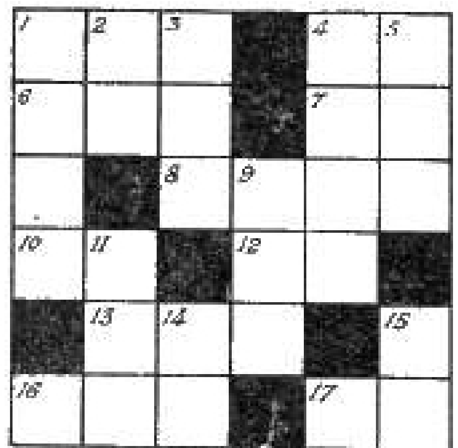
University College, London.

Yours faithfully,
MICHAEL LEVISON.

Mr. Chittenden and Mr. M. Eastham, Manchester Grammar School, have written to us on similar lines.

JUNIOR CROSS-FIGURE. No. 18

Suggested by Judith Cory, Form 5, Girls Grammar School, Dartford, Kent.



ACROSS.

1. Value of $x^2 + x - 8$ (see 7 across).
4. $16\frac{2}{3}$% of a chain in feet.
6. Calculate length BC (Fig. 1).
7. x, when $2(x-6) = 7(15-x)$.
8. Sum of the remaining interior angles of a convex decagon if one of its angles is 41°.
10. CCCXCII ÷ VII.
12. A fifth of 16 across.
13. L.C.M. of 18, 45 and 120.
16. The product of three consecutive prime numbers.
17. $(3\frac{[illegible]}{[illegible]} - 1\frac{1}{[illegible]}) \div 1\frac{1}{[illegible]} \times \frac{[illegible]}{[illegible]}$.

DOWN.

1. p^2q^3, if $2p - 3q + 1 = 3p - 4q - 1 = 0$.
2. What percentage is 45 marks out of 60 marks?
3. Number of lbs. in ·18795 tons.
4. Three times the sum of 7 across, 13 across and 15 down.
5. The supplement of angle d (Fig 2).
9. Reflex angle D, where ABCD is a parallelogram with angle C = 140°.
11. $3pq(1+q)$ (see 1 down).
14. Simple interest on £520 for 4 years at $3\frac{1}{8}$%.
15. H.C.F. of 864, 1680 and 2520.

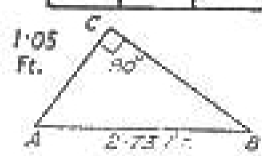


FIG. 1

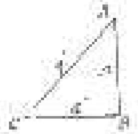
FIG. 2

I.H.

FALLACY No. 20

Problem: Find the largest angle of the triangle whose sides are 7, 9 and 4 units.

Figure:



Working: From triangle, $\sin C = \frac{9}{7}$

$\therefore \quad \sin C = 1{\cdot}2857$

But since $\sin 90^\circ = 1$

and $\sin 16^\circ 36' = {\cdot}2857$

$\therefore \quad C = 90^\circ + 16^\circ 36' = \underline{106^\circ 36'}$

which is the correct value!

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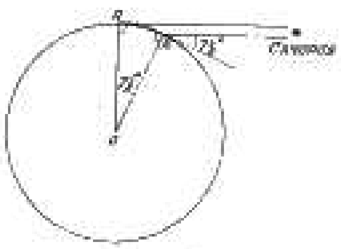
THE WORLD ENCOMPASSED. No. 2

Poseidonius

The measure of the Earth's circumference made by Eratosthenes (Mathematical Pie, No. 11) was generally accepted for over a century, until about 100 B.C., when Poseidonius made a further attempt at an accurate measurement.

Poseidonius was a Stoic philosopher whose name is linked with astronomy, geography and politics. Like most of the philosophers of this period he travelled widely in the Mediterranean countries before opening his own school at Rhodes, which was attended by both Cicero and Pompey.

The method of measurement employed by Poseidonius was similar to that of Eratosthenes in that he selected a known arc of a meridian. The arc he chose extended from Rhodes to Alexandria but where Eratosthenes had used the shadow cast by the sun in two different places, Poseidonius used the elevation of a particular star. He noticed that when the star Canopus was on the horizon at Rhodes it was about $7\frac{1}{2}^\circ$ above the horizon at Alexandria, that is $\frac{1}{48}$ of 360°. This made the circumference of the Earth 48 times the distance between the two cities, which was measured as 5,000 stadia. His calculations therefore made the circumference of the Earth to be about 240,000 stadia.



$\angle ROA = \frac{1}{48}$ of 360°

$\therefore$ arc RA $= \frac{1}{48}$ of circumference $= 5000$ stadia

$\therefore$ Circumference $= 240{,}000$ stadia

According to Pliny a stade was 125 paces, i.e., Greek 625 feet (a Greek foot was about 12.15 inches) and this would give the circumference of the earth as about 28,760 miles. This was not such a good result as Eratosthenes; and no doubt the main source of error came in measuring the distance from Rhodes to Alexandria.

All the early measurements of the Earth's circumference imply the use of some system of mapping comparable with the idea of latitude and longitude. Hipparchus of Nicaea (c. 140 B.C.) is credited with the introduction of latitude and longitude, though very little definite information as to the nature of his system has survived to the present day. The equator as the zero line for measurement of latitude appears to have been a natural and generally accepted idea, but many centuries of controversy preceded the acceptance of the meridian through Greenwich as the zero of longitude.

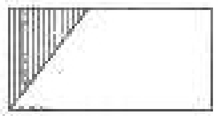
In the 17th century, Cardinal Richelieu proposed as the starting point of longitude, the meridian through Ferro, in the Canary Isles, because it lay west of the Old World and east of America. Later, the position of Ferro was reckoned as 20° W. of Paris. The Greenwich meridian first came into use as the zero line on sea-charts and it was generally accepted as the universal prime meridian at a conference held in Washington in 1884, though many countries still took the prime meridian as the one through their own particular capital. I.L.C.

very fine powder for some processes. It is the job of the physicist to investigate how this can be done most efficiently, thereby giving him an opportunity of using mathematical devices which look very unpromising when first encountered in an algebra book.

The production of useful power by using atomic energy involves the employment of physicists on the grand scale. It is apparent, therefore, that the demand for physicists is spread over many industries, and will be heavy for a long time to come. J.F.H.

MATHEMATICAL JIGSAW No. 3

Contributed by Canon D. P. Eperson, Bishop Otter College, Chichester.



Take any rectangular piece of paper, or cardboard, and cut off one corner. How can you cut the remaining trapezium into two pieces, which will fit together to make a triangle?

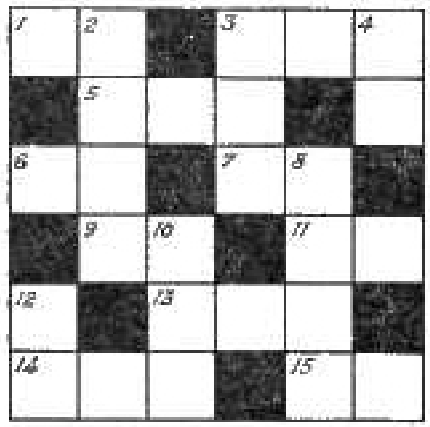
(There are four solutions to this problem.)

WHY IT WAS CALLED—No. 6

SINE: Latin *sinus* (curve, bay, gulf, etc.) rendered by a translator for *jb* which he took to be the Arabic word *jaib* (a curve). In Arabic script the vowels are often omitted; the translator should have read *jiba* which was the Arabic rendering of the Hindu word *jira*, applied by the mathematician Argabhata (approx. 500 *A.D.*) as a term for the ratio that the schoolboy remembers as "opposite over hypotenuse."

COSINE: From *co-*, prefix form of Latin *cum* (with) and *sine*, hence the sine of the *complement* of an angle. J.F.H.

SENIOR CROSS-FIGURE. No. 20

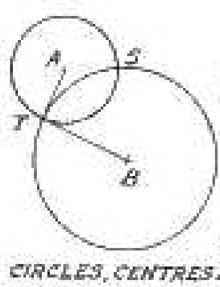


ACROSS.

1. Change of income in shillings, to the nearest shilling (see 2 down).
3. A root, correct to three significant figures, of $3x^2 - 14x + 10 = 0$.
5. Length AB (see figure 1).
6. Area, to the nearest sq. ft., of roofing felt required for the shed (see figure 2).
7. Angle ABT (see figure 1).
9. Twice the volume of the shed in cubic yards (see figure 2).
11. $a - b$, where $a + b = 49$ (see 10 down).
13. Thrice the external surface area, in sq. ft., of the sides and ends of the shed (see figure 2).
14. Length ST (see figure 1).
15. $\left(\frac{a}{b}\right)^{-3}$, correct to two decimal places (see 11 across and 10 down.

DOWN.

2. The number of 4% 5/- shares at 4/6d. that can be purchased by selling £1260 of $5\frac{1}{4}$% stock at 117.
3. The product of the roots of $3x^2 - 14x + 10 = 0$.
4. The product of the largest prime factor of 2 down and that of 8 down.
8. The price that a number of articles must be sold to make a profit of 5% if by selling them for £1140 a loss of 5% is made.
10. ab, where $a^2 - b^2 = 1225$ (see 11 across).
12. The distance, in miles, a motorist travels if by increasing his speed by 4 m.p.h. and by 9 m.p.h. he saves $2\frac{1}{2}$ minutes and 5 minutes respectively.



CIRCLES, CENTRES A & B, SUCH THAT AT LENGTH 3 CMS. & BT 5 CMS ARE TANGENTS.

FIG. I.

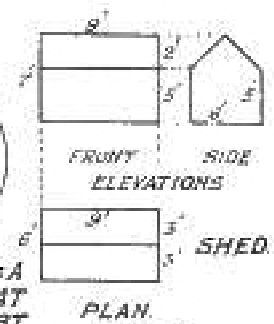
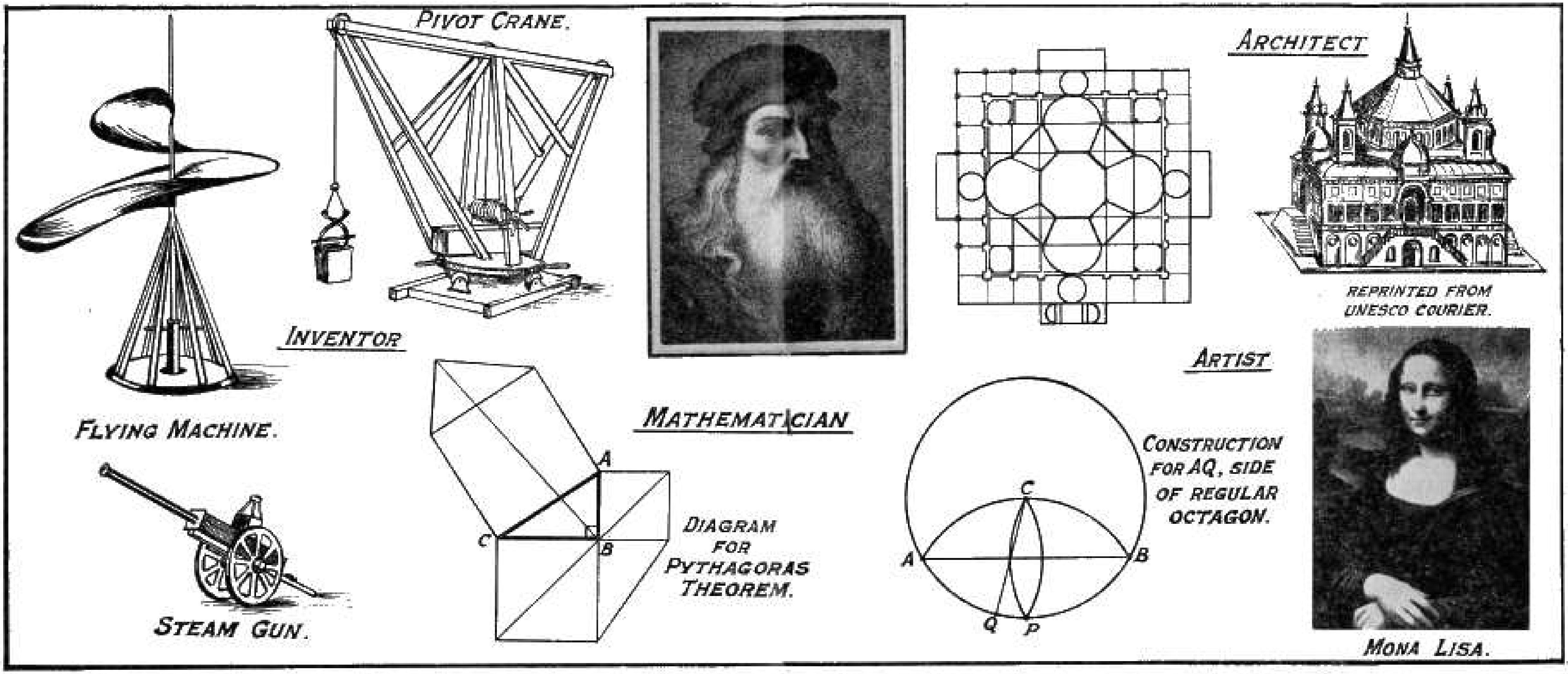


FIG. 2.

CHECK CLUE.

When complete, the sum of all the digits inserted in the Cross-Figure is a prime number. I.H.

FAMOUS MATHEMATICIANS No. 5—LEONARDO DA VINCI (1452-1519)



Leonardo da Vinci was one of the greatest of the Italian painters who enriched the artistic life of the 15th century; an age remarkable for exquisite paintings; but he was also sculptor, architect, scientist and mathematician.

Although the 15th century was a great artistic era, scientific progress at that time was almost non-existent. Many of the Greek ideas, nearly 2000 years old, were accepted as unchanging and eternal truths. Aristotle (384—322 B.C.) had pronounced his views on science and philosophy and these were so completely accepted that some of his errors remained uncorrected until the 17th century.

Leonardo was one of the few who questioned the old beliefs, for his observations, reasoning and experiments contradicted them. Originally, these observations were made purely from an artistic point of view. Leonardo wished to understand the nature of the subjects he painted; so he studied, amongst other things, anatomy, the mechanics of a bird in flight, and the transmission of waves through water. All his ideas and observations were recorded in his notebooks, and these notes make very interesting reading. Although it was always his intention to sort and tabulate these notes, Leonardo never accomplished the task.

Leonardo da Vinci has always been remembered for his wonderful

49999 99837 29780 49951 05973 17328 16096 31859

paintings, the "Last Supper," the "Mona Lisa" and many religious subjects, but his writings were scattered and forgotten until they were rediscovered, many years after his death, in the libraries and archives of the capitals of Europe. There were 5000 sheets of manuscripts containing thousands of beautiful drawings and architectural designs.

In these notes we find many startling ideas and plans. As the result of careful observation of the sky and the motions of the sun, moon and stars, Leonardo came to the conclusion that many of the prevailing ideas in astronomy were wrong. On one page of his notes there is written, in large letters: "The sun does not move." This same idea was put forth by Galileo a hundred years later and was condemned as heresy!

Leonardo da Vinci had an unusually far-sighted brain on the subject of practical science and this quality gave rise to numerous inventions and designs. Although this was only the 15th century, Leonardo designed a flying machine, instruments of war and many labour-saving devices.

One cannot describe Leonardo da Vinci as a great mathematician, but he will surely be remembered for his amazing clarity of thought in mathematical and scientific reasoning; as well as for his beautiful paintings.

I.L.C. & J.G.

50244 59455 34690 83026 42522 30825 33446 85035