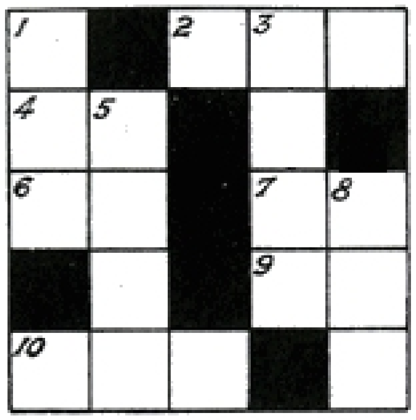
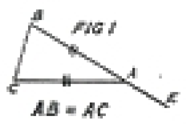
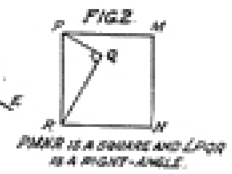
JUNIOR CROSS-FIGURE. No. 17

Suggested by Patricia Walker, Form VI upper Stockport High School for Girls.







ACROSS

2. ∠CAE, given that ∠BCA = 70° (see figure 1).
4. Area of PMNR if PQ = 5 cm. and RQ = 6 cm. (see figure 2).
6. Simple interest on £826 13s. 4d. for 18 months at 5% per annum.
7. (CDXLV — CXX) ÷ V.
9. The reciprocal of 7·692.
10. Number of farthings in £·3625.

DOWN

1. $(3\frac{1}{2} + 2\frac{3}{7}) \div (1\frac{4}{21} - \frac{5}{6})$.
3. x^2 where $3(x - 3) + 2(x + 6) =$ "10 across."
5. $\dfrac{1{\cdot}68 \times 2{\cdot}805}{2{\cdot}75 \times {\cdot}0014}$.
8. The number of cabbages planted in rows of 41, if a farmer plants 1,050 cabbages in 24 rows some of 41 in a row and the remainder 47 in a row.

I.H.

SOLUTIONS TO PROBLEMS IN ISSUE. No. 18

ARABIAN (K)NIGHT'S HOMEWORK

In the same order as the original problems the answers are :

٣٧	١٠
٣	٦
٧٠٠	٢٥
١٤٤	٦
٥٣	١٠

MATHEMATICAL LIMERICK No. 4

Clutterbuck made 13 runs.

SENIOR CROSS-FIGURE No. 18

Across : (2) ·125 ; (4) 3200 ; (7) ·375 ; (9) 250 cm. ; (11) £1232 ; (14) 169.

Down : (1) 33 ; (2) 10° ; (3) 203 ; (5) 22.5 m.p.h. ; (6) 7½ ; (8) 7·43 cm. ; (9) 28 ; (10) 2·16 ; (12) 29° ; (13) 26.

FALLACY No. 18

Neither method is correct, for, in the figure, ∠DPA must equal 30° if PC = CD = AO. Then both methods give ∠COP = 30°.

JIGSAW No. 2

12 parallelograms can be made with 2 or more of the pieces.

Using both A's.

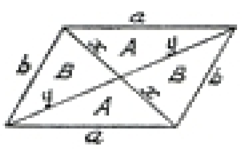
1. Join along a — sides x & y.
2. Join along x — sides a & y.
3. Join along y — sides a & x.

Using both B's.

4. Join along b — sides x & y.
5. Join along x — sides y & b.
6. Join along y — sides b & x.

Using all 4 pieces.

7. Join 1 & 4 along side x to make sides 2y & x.
8. Join B to opposite sides of 1 to make sides 2y & b.
9. Join B to opposite sides of 1 to make sides 2x & b.
10. Join 1 & 4 along side y to make sides 2x & y.
11. Join A to opposite sides of 4 to make sides 2x & a.
12. Join A to opposite sides of 4 to make sides 2y & a.



ROMAN CROSS-FIGURE No. 1

Across : (II) LX ; (IV) CXXI ; (VI) III ; (VII) VII.
Down : (I) CCI ; (II) LXII ; (III) XI ; (V) XIV.
Method : (1) VI ac ; (2) III dn ; (3) V dn ; IV ac ; (4) VII ac ; II dn ; (5) II ac ; (6) I dn.

FUN WITH NUMBERS NO. 4 (CHARLIE COOK)

The other three fractions are : $\frac{26}{65}$, $\frac{19}{95}$, $\frac{49}{98}$.

JUNIOR CROSS-FIGURE No. 16

Across : (1) £108 ; (4) 154° ; (6) 484 ; (7) 147 ; (9) 5·76.
Down : (1) 18 m.p.h. ; (2) ·81875 ; (3) 24 cm. ; (5) 5·4 ; (6) 44 ft. ; (7) 14 ; (8) 9·6.

I.L.C.

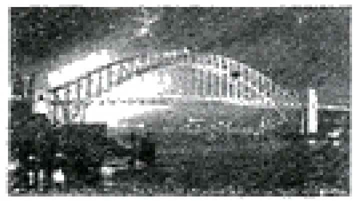
00056 81271 45263 56082 77857 71342 75778 96091

MATHEMATICAL PIE

NUMBER NINETEEN — *Editorial Offices:* 97 Chequer Road, Doncaster. — OCTOBER 1956

SOME REMARKABLE BRIDGES

Svinesund Bridge, Norway. Steel and reinforced concrete. Main arch is a Parabola ; small arches semicircles.



Sydney Harbour Bridge, Australia. A steel parabolic arch nearly ⅓ mile long. Cost of building £4,217,721/11/10.

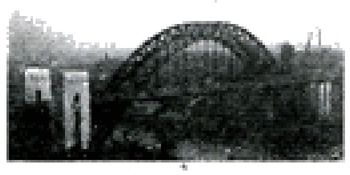
Victoria Falls Bridge, Africa. A masterpiece in steel on the Cape to Cairo Railway. The track is 420 feet above the river.

According to G. K. Chesterton, a bridge is "a road that flies." As it leaps over a river, a sea, a chasm or a highway, it performs the function of supporting weights in mid-air. But if it is to do this without falling down it must be carefully designed, and it is the job of the engineer to achieve this by making use of his experience as well as his mathematical knowledge.

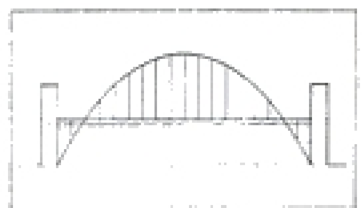
The loads going across the bridge, and the weight of the bridge itself, can act in a variety of ways on the materials from which the bridge is constructed. They may be compressed, stretched lengthwise (in *tension*) or strained across their lengths (in *shear*) ; the bridge may oscillate both up and down as well as from side to side (the Sydney Harbour Bridge may sag as much as 4½ inches under heavy loads) ; a strong wind may even tend to twist it (in *torsion*). Heat and cold will affect it by changes in length.

It must therefore be built strongly enough to withstand these demons of destruction, and to last for centuries, and in consequence, when it is being planned, the mathematics of tension, compression, shear, and torsion must follow the design work, and geometry must help in its building.

Bridges may even illustrate the solutions to examination problems!



Tyne Bridge between Newcastle and Gateshead.



Skeleton structure of the same bridge.

Solution of problem "Draw graph of $y = 5x - x^2$ from $x = 0$ to $x = 5$, and use your graph to solve the equation $x^2 - 5x + 2 = 0$.

J.G.

RADICALLY WRONG

Suggested by A. J. Harris, Form 2K, Southern Grammar School, Portsmouth.

Boy : Please sir, I have brought this plant for your Mathematics Exhibition.

Teacher : Indeed! What connection has it with mathematics?

Boy : Sir, it has square roots!

J.F.H.

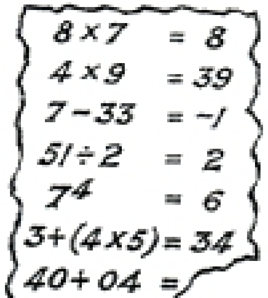
48815 20920 96282 92540 91715 36436 78925 90360

MARTIAN MATHEMATICS

Suggested by M. P. Saward, UVI Sc., Grammar School, Dartford, Kent.

The first explorers landing on Mars were much puzzled by the figures for height and speed given to them by the Martian Spaceport Control during the "talk-down" prior to landing. Fortunately, their instruments in the spaceship made the landing quite automatic and safe.

On landing, they made enquiries and found that, while the signs $+$, $-$, $\times$, $\div$, etc., had the same meaning as on Earth, the numbers, outwardly exactly the same as Earth numbers, had different actual values; thus 5 did not stand for the number of fingers usually found on a human hand, but for some other number.



When the explorers returned to Earth, one of them removed a piece of paper, which had been wedged in one of the spaceship windows to stop a rattle. He found it was a piece torn from a Martian schoolboy's exercise book; and, further, that it gave sufficient information to find out all the Martian equivalents for Earth numbers. The torn piece is reproduced here; can you find *(a)* the missing Martian answer to the last sum? and *(b)* the Martian equivalents to the Earth numbers? J.F.H.

This series is intended to present some simple tricks with ordinary playing cards, which, if properly mastered and well practised, will amuse and mystify. The methods used are based on mathematics, and require little or no skill at card manipulation.

No. 1. The Sympathetic Sevens

Effect: Seven red and seven black cards are thoroughly mixed, put behind the back, and produced again with *red cards only* face upwards in one hand, and an *equal* number of *black cards only* face upwards in the other hand. The cards are again shuffled, and again produced with a similar result. This may be repeated several times showing "sympathy" between the red and black cards.

Method: The following instructions will be more easily understood if the cards are handled while reading.

Choose seven red and seven black cards from a pack. Show them to be ordinary cards by having the seven red cards spread out, fanwise, face upwards in one hand, and the black, likewise, in the other. Place the two sets of cards face together, and mix them, allowing them to be cut if desired. The cards will, of course, be different ways round, and care must be taken, while mixing, that no card is turned over.

Hide the fourteen cards behind the back, and count, quickly and silently, seven cards from the pack to the other hand. Turn these seven cards over.

This done, show the cards again, and it will be found that there are equal numbers of red cards face upwards in one hand as there are black in the other.

CHARLIE COOK

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

Problem: To find the area of a triangle base 2′ 8″, height 2′ 3″. (Answer in sq. ft.). (From "Kingsway Mathematics," Blue Book 2, Ex. 30, 6(d)).

Charlie's method: (Multiply numbers of inches together, and express in feet by dividing by 12!!!—then multiply the numbers of feet together; add the two results)

$$\begin{array}{rrl} \text{ft.} & \text{ins.} & \\ 2 & 8 & \\ \times\ 2 & 3 & \\ \hline 4 & 24 & = 2\text{ ft.} \\ +\ 2 & & \\ \hline 6 & & \therefore \text{ area of triangle} = 3 \text{ sq. ft.} \\ \hline \end{array}$$

Correct method: $2'\,8'' = 2\tfrac{2}{3}$ ft., $2'\,3'' = 2\tfrac{1}{4}$ ft. $\therefore$ Area of triangle $= \tfrac{1}{2} \times 2\tfrac{2}{3} \times 2\tfrac{1}{4}$ sq. ft. $= \tfrac{1}{2} \times \tfrac{8}{3} \times \tfrac{9}{4}$ sq. ft. $= \underline{3 \text{ sq. ft.}}$

Note.—It is not possible to obtain the correct answer by Charlie's method, unless the measurements are (i) 1′ 4″ or 2′ 8″ and (ii) 2′ 3″, 4′ 6″ or 6′ 9″. This means that only in six cases out of the doubly infinite set $(x'\,y'') \times (p'\,q'')$ does the incorrect method give the correct answer. (x and p can be any positive integers, y and q can be any positive integers less than 12). Can you prove this?

You have to find all the integral solutions to

$$\left(x + \frac{y}{12}\right)\left(p + \frac{q}{12}\right) = xp + \frac{yq}{12}$$

Canon Eperson (address as above) offers to send a copy of the "Lewis Carroll Puzzle Book" to the first five persons under 19 years of age who send him a correct answer.

LETTER TO THE EDITOR. No. 2

I have never gone beyond 72 places in calculating π myself; but I have the 808 places sent to me by D. F. Ferguson, the World's record holder; and in these the 45th block of five figures appears as 28475, not 28474 as in this (May, 1956) month's Math. π, page 138.

W. HOPE-JONES B.A. (late Cranleigh School).
Shamley Green, Guildford.

Editor: *Our Mistake. Readers will no doubt have noticed that the article immediately above this error was entitled "Few are Perfect."*

WHY IT WAS CALLED—No. 5. PARTS OF TRIANGLES

VERTEX: Latin, *vertex* = a turning point or summit (related to *vortex*).
HYPOTENUSE: Latin, *hypotenusa* from Greek *hupoteinousa (gramme)* = subtending line.
MEDIAN: Latin, *median(us)* = middle.
PERPENDICULAR: Latin, *perpendicul(um)* = weighted line = plumb line.
SIDE: Middle and Old English, *side*, connected with Old English *sid* = spacious, broad.
ALTITUDE: Latin, *altitudo* from *altus* = high.
ADJACENT: Latin, *adjacent(em)* from Latin *adjacere* = to lie at or near.
OPPOSITE: Latin, *opposit(um)* from Latin *opponere* = to place. J.F.H.

In 1585, Stevin published an essay on decimals in which he stated that this new system of numbers "Teaches how all Computations that are met in Business may be performed by Integers alone without the aid of Fractions." In his notation, 1·732 would appear as 1732_3 or as $1_0 7_1 3_2 2_3$, or as $1^0 7^1 3^2 2^3$.

In the following year, Stevin published treatises on statics and hydrostatics. Following the method used by Archimedes more than 1800 years earlier, he found the centre of gravity of a triangle, the pressure of water against a dam and determined the force necessary for the equilibrium of a body placed on an inclined plane. I.L.C.

FALLACY No. 19

A hotel manager, faced with the problem of accommodating 10 guests in 9 single rooms, devised a solution as follows: he requested two guests to wait in room No. 1, then put the third guest in room No. 2, the fourth in room No. 3, and so on until he had put the ninth guest in room No. 8. He now fetched one of the two guests from room No. 1, and put him in room No. 9.

Now, this would make it appear that $\frac{10}{9}$ = an integer. Does it?

J.F.H.

CAN AL HAVE AN ANSWER

We should explain that Al is the skipper of a canal barge rejoicing in the name of *The Argument*. In the course of a voyage from one town to another, he came to a bridge where the canal crossed a main road. His barge was loaded with 25 tons of iron blocks, which Al knew to be approximately eight times as heavy as water. To Al's practical eye, the bridge did not look strong enough to carry an extra 25 tons, and he wondered whether he should risk crossing it with his loaded barge. Would you?

Suppose Al did risk the crossing, and that the bridge would in fact carry an extra 22 tons. If, when half way across, the bottom drops out of *The Argument* and releases the load, what would happen? J.F.H.

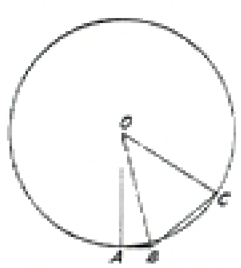
DO YOU KNOW?

1. To square a number ending in $\frac{1}{2}$ (e.g., $5\frac{1}{2}$); multiply the whole number (5) by the next whole number (6) and add $\frac{1}{4}$. E.g., $(8\frac{1}{2})^2 = 8 \times 9 + \frac{1}{4} = 72\frac{1}{4}$.

2. Unless the meaning of the word "multiply" is drastically changed, it is impossible to *prove* that minus times minus is plus; but the rule always works.

3. If you write the first three odd numbers twice each, thus, 113355, and then put the last three over the first three, thus, $\frac{355}{113}$, the value of this fraction differs from the real value of π (erroneously thought to be $3^1/_7$) by less than 1 part in ten million.

Using the value of $\frac{355}{113}$ to calculate the length of the equator from the diameter of the earth (assumed circular) the error would be *less than eleven feet*.



4. Draw any circle, radius 4 units, centre O. At any point A, draw a tangent AB, 1 unit in length. With centre B, radius 3 units, draw an arc, cutting the circle at C, A and C being on opposite sides of OB. Then the angle AOC is very nearly equal to a radian, that is, the length of the curved arc AC is almost equal to the radius. The error is less than one part in a thousand; it is less than the angle made by a halfpenny at a point 30 yards away.

It is interesting to check this statement by Trigonometry. J.G.

To repeat this "sympathy," place the two exhibited faces together, shuffle, and proceed exactly as before.

If someone to whom you are showing the trick thinks he has found the secret, put the two sets of cards together so that the exhibited face of one set is against the back of the other, mix, and hand them to him to put behind his back—it will not turn out as he expects!

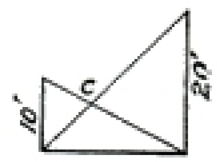
For the best effect, all moves should be carried out deliberately, and any suspicious actions avoided.

Principle: After placing the cards together, there are seven red cards facing one way, and seven black cards facing the opposite way. Shuffling and separating the cards into two sets of seven does *not* alter this.

It follows that if there are four red cards face upwards in one set there must be three, 7 — 4 = 3, facing upwards in the second together with four, 7 — (7 — 4) = 4, black cards face downwards. Reversing the second set thus brings an equal number of red and black cards face upwards in the two sets. I.H.

POLES APART

Suggested by N. C. Cooke, Esq., North Road School, Stoke-on-Trent.



Two vertical poles, 10 feet and 20 feet high, stand on horizontal ground. The top of each is connected to the foot of the other by straight wires, which meet at a point C. How high is C above the ground?

No further data is required for solving this problem, which may be dealt with either by a scale drawing, or by calculation. Some interesting facts about this problem will be described in our next issue. J.G.

SENIOR CROSS-FIGURE. No. 19

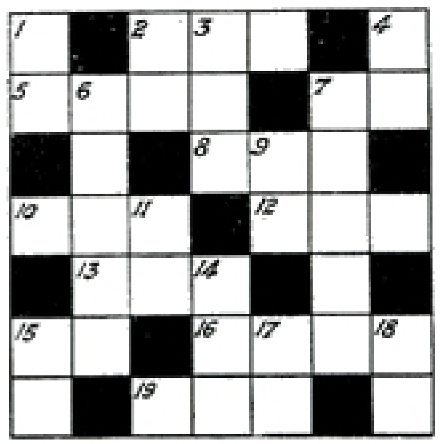
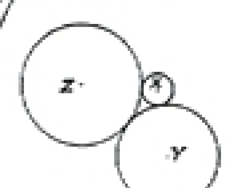


FIG. 1.

AB = AC, 3AE = 2EC AND BA IS PARALLEL TO CP.

FIG. 2.

CIRCLES, CENTRES X, Y AND Z, TOUCH EACH OTHER AND HAVE RADII 2, 7 AND 8 CM.



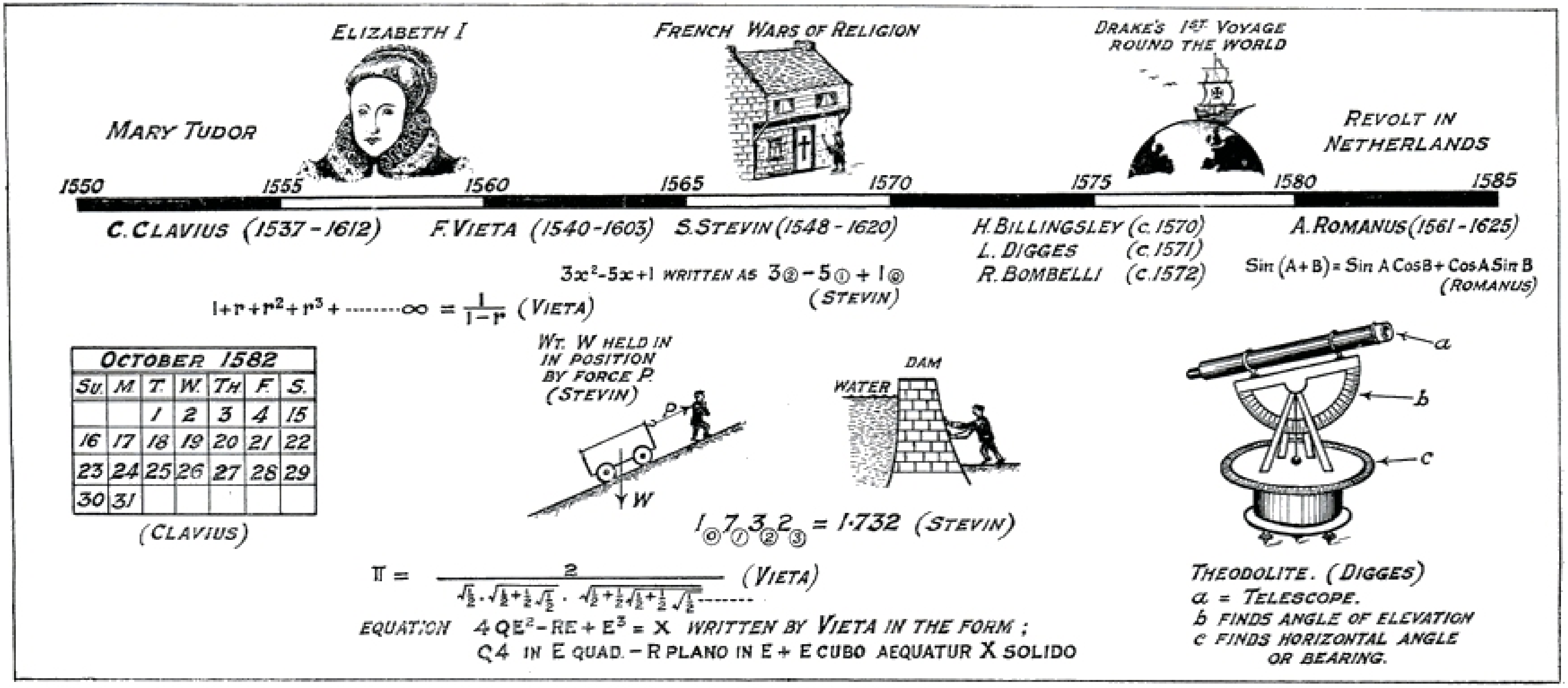
ACROSS

2. Half the area of $\triangle XYZ$ (see figure 2).
5. The sum of the first 32 multiples of 7 after 25.
7. $\angle BPC$, when AB = 8 in., BC = 12 in. and CA bisects $\angle BCP$ (see figure 1).
8. One root of $x^2 - 2x - 7 = 0$.
10. Largest angle of $\triangle XYZ$ (see figure 2).
12. Twice the cube root of the reciprocal of "4 down."
13. $(2p - 3)(2 - 3p)(1 - 4p)$ when $p = (18\ \text{down})^{\frac{1}{2}}$.
15. $\angle AEP$, to nearest degree, if the angles of $\triangle ABC$ are in the ratio 1 : 2 : 2 (see figure 1).
16. Area of circle of diameter "19 across" feet.
19. $2\frac{1}{8} \times 3\frac{3}{14} \div 1\frac{1}{2}/7 - 2\frac{1}{8}$

DOWN

1. The difference, in shillings, between the Compound and Simple interest on £275 for 3 years at $4\frac{1}{2}$%.
2. $3x - y$, if x and y satisfy the equations $x + y = 10$ and $xy + 2y^2 = 11$.
3. The other root of $x^2 - 2x - 7 = 0$.
4. Area of $\triangle BPC$ if AB = 13 cm. and BC = 10 cm. (see figure 1).
6. The square of "14 down."
7. The square of "3 down."
9. Find z if $\sqrt{z - 2} + \sqrt{z - 8} = \sqrt{10}$.
11. Geometric mean of s and t if $3s - t + 15 = 4s - 2t - 8 = 2s + t + 5$.
14. Length of CP if AB = 13 cm. and BC = 10 cm.
15. $3x + y$ (see "2 down").
17. Five times one half of "1 down."
18. Fourth proportional of 5, 9 and 45.

I.H.



During the 16th century, the rapid progress made in the study of algebra was largely due to the improvement of algebraic symbolism. Many symbols were tried and discarded; and, even at the end of the century, the now well-known notation was far from complete.

Early in the century much work had been done in the field of cubic and quartic equations; but the chief stumbling-block was the failure to recognize negative roots. This work was continued by Rafael Bombelli who, in 1572, published his "Algebra" in which he considered the roots of equations in great detail and laid the foundation for the future study of imaginary numbers.

The most eminent algebraist of this period was the Frenc mathematician François Vieta, who made considerable improvements in algebraic notation by introducing the use of letters to represent numbers. As a lawyer and a privy counsellor, he studied mathematics as a recreation, publishing his works only for distribution among his friends. Generally, Vieta used capital letters only, having consonants for known quantities and vowels for unknown quantities. The terms "coefficient" and "polynomial" appear frequently throughout his work, although they were not in general use until the close of the 17th century; and he was the first mathematician to apply algebraic transformations to trigonometry.

In the study of trigonometry, progress was made in the consideration of compound angles, and Adrian Romanus gave the first proof of the formula for $\sin(A + B)$.

Unlike algebra, geometry made little advance during the Renaissance, but there developed a more intimate knowledge of Greek geometry. In 1570, Sir Henry Billingsley made the first English translation of Euclid direct from the Greek.

From the point of view of practical mathematics, it is worth noting the invention by Leonard Digges, in 1571, of the theodolite for land-surveying; and also the review of the calendar. Owing to the annual confusion with regard to the determination of movable feast-days, Pope Gregory XIII invited a number of mathematicians and astronomers to suggest a remedy. The result was the adoption of a calendar proposed by Christophorus Clavius of Rome. In order to rectify the discrepancies in the existing calendar, it was agreed to write, in the new calendar, October 15th immediately after October 4th for the year 1582. It was not until 1752 that the Gregorian Calendar was adopted in England, when eleven days had to be omitted.

Finally, we come to the Belgian, Simon Stevin, who is noted for his work on decimals and for his revision of the ideas of Archimedes in Statics.