FALLACY No. 25

Contributed by Mr. D. Howell, S.W. Herts. Further Education Centre, Watford.

Let $a^x = -1$ (1) Squaring, $1^{2x} = +1 = a^o$

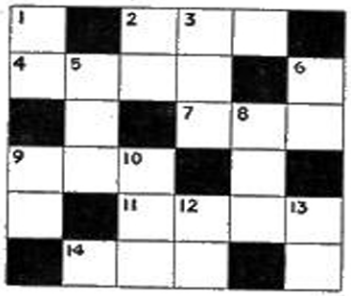
$\therefore \quad 2x = 0$

$\therefore \quad x = 0$

Hence, from (1) $a^o = -1$

But $a^o = +1$, $\therefore 1 = -1$.

JUNIOR CROSS-FIGURE No. 24



ACROSS

2. $12\left(\frac{2}{3} \div \frac{8}{9} \div \frac{3}{27}\right)$.
4. $\frac{1}{12}$ of 11 ac. $-$ 5 dn. $-\frac{1}{2}$ of 14 ac. $+$ 1.
7. Square yards in $\frac{3}{20}$ of an acre.
9. y^2 (see 1 dn.)
11. L.C.M. of 420, 115, 322.
14. $\frac{444}{\sqrt{4}} - \sqrt{4}$.

DOWN

1. Value of x given by $x - y = 3$, $5x - 6y = 3$.
2. Pence in $\frac{3}{4}$ of half-a-crown $\div \frac{3}{8}$ of a shilling.
3. Average speed in m.p.h. of a Comet which flew 2,950 miles in $6\frac{1}{4}$ hours.
5. Reverse of 10 dn.
6. Number of sides of a regular polygon whose interior angle is 150°.
8. Twice 2 ac.
9. Area in square yards of a border 3 ft. wide surrounding a carpet 3 yards square.
10. See 5 dn.
12. $\frac{1}{3}$xy (see 1 dn.)
13. 3s 3d. as a decimal of £3 5s.

I.L.C.

SOLUTIONS TO PROBLEMS IN ISSUE No. 25

PIED PIPER.
15 at 2s. 1d. and 33 at 4s. 1d.

POSTMAN'S KNOCK.
There are only 10 different digits, *viz.*, 0, 1, 2, - - - 9.

SENIOR CROSS-FIGURE No. 25.
ACROSS : (2) 488 ; (5) .7782 ; (7) 49° ; (8) 448 ; (10) 135° ; (12) 7, 6, 5 ; (13) 441 ; (15) 80 ; (16) 6162 ; (19) 189.
DOWN : (1) 27 ; (2) 48 ; (3) 824 ; (4) 29 ; (6) 76340 ; (7) 48636 ; (9) 47; (11) 54° ; (14) 168 ; (15) 84 ; (17) 19 ; (18) 24.

SEVENTH HEAVEN.
There are two possible ways of dividing the casks of wine.

	A	B	C		A	B	C
Full	3	3	1	OR	3	2	2
Half-full	1	1	5		1	3	3
Empty	3	3	1		3	2	2

ATENSION.
The tension in the first coupling must be equal and opposite to the frictional resistance to six trucks. The tension in the second coupling must be equal and opposite to the frictional resistance to five trucks ; and so on.
Since the tension in the first coupling is 100 lb. and the trucks are equally loaded ; the remaining tensions are : $\frac{5}{6}$ of 100 lb. = $83\frac{1}{3}$ lb. ; $\frac{4}{6}$ of 100 lb. = $66\frac{2}{3}$ lb. ; $\frac{3}{6}$ of 100 = 50 lb. ; $\frac{2}{6}$ of 100 lb. = $33\frac{1}{3}$ lb. and $\frac{1}{6}$ of 100 lb. = $16\frac{2}{3}$ lb.

£. s. d. $\frac{240}{253}$

JUNIOR CROSS-FIGURE No. 23.
ACROSS : (2) 144 ; (3) 263 ; (5) 37.5% ; (7) 191.
DOWN : (1) 3456 ins. ; (3) 28.3 sq. ins. ; (4) 35.5 lb. ; (6) 789 ; (7) 12 ; (8) 18d.

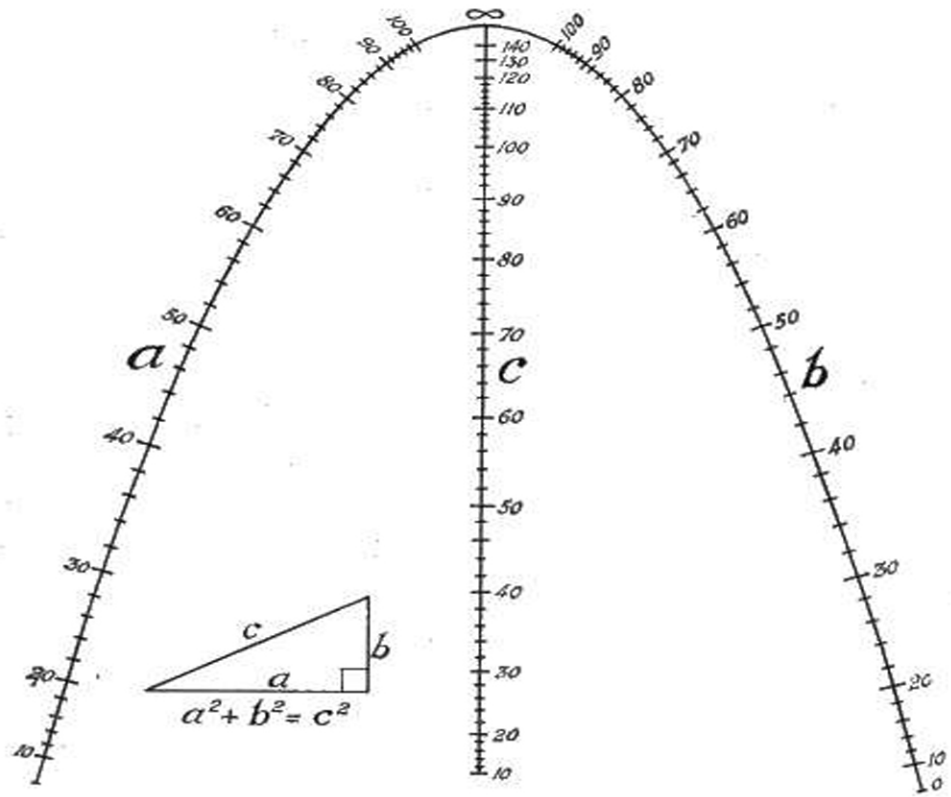
I.L.C.

33214 45713 86875 19435 06430 21845 31910 48481

MATHEMATICAL PIE

No. 26 *Editorial Offices :* 97 Chequer Road, Doncaster **FEBRUARY, 1959**

NOMOGRAM FOR PYTHAGORAS



If any two sides of a right-angled triangle are known, the nomogram can be used to find the third side. To find the hypotenuse of a right-angled triangle whose perpendicular sides are 33 in. and 56 in., lay a straight-edge from 33 on the *a*-scale to 56 on the *b*-scale. It cuts the *c*-scale at 65. The hypotenuse is therefore 65 in. If the measurements do not lie conveniently on the scales a scale factor can be used.

C.V.G.

60101 50330 86179 28680 92087 47609 17824 93858

MATHEMATICAL INSTRUMENTS No. 6.

The Sacred Calabash

The people of Hawaii regularly made the long voyage of 2,300 miles to Tahiti in the Society Islands. The canoe crews were selected with great care and undertook a period of strenuous training. Great double canoes, ninety feet long with a covered deck-house on the platform between the two hulls, were loaded with stores and when all was ready the Sacred Calabash was carried on board.

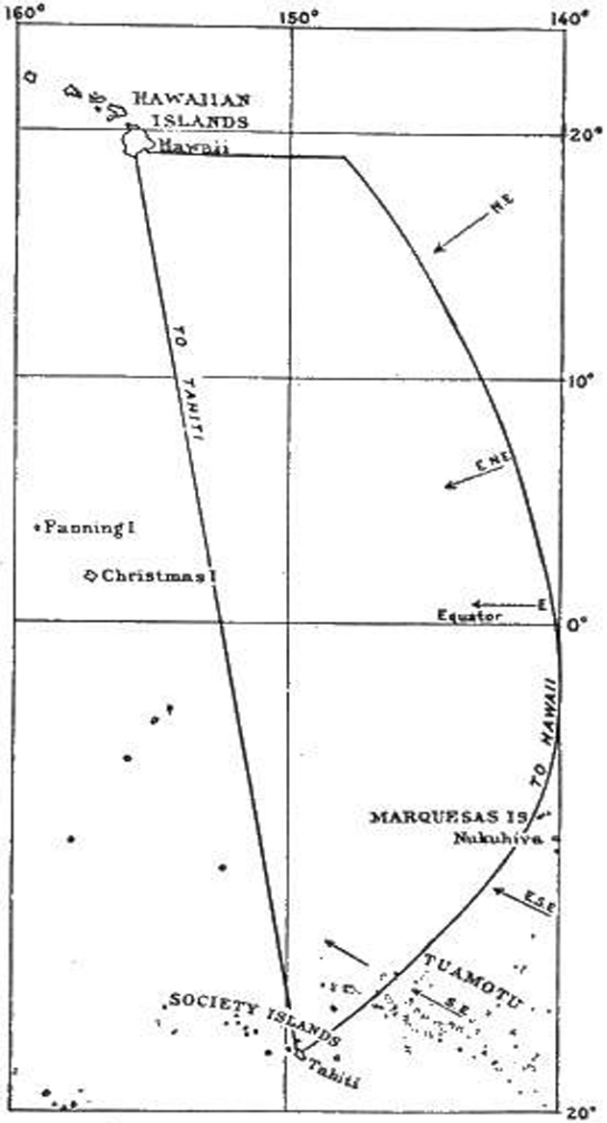


Diagram showing approximate courses from Hawaii to Tahiti and return.

Arrows indicate direction of prevailing winds

For the first half of the journey the canoe was out of sight of land. A course was steered a little to the east of south. The Sun was the guide by day and the Pole Star by night until it dropped below the horizon as the equator was crossed. South of the equator the travellers entered an area with many groups of islands and atolls and these were their guide to Tahiti.

On the return journey the course was laid to the east of north through the Marquesas, because the prevailing winds and currents would tend to carry the canoe to the westward. The islanders had a thorough knowledge of winds and currents. There still survive many "charts" made of strips of wood bound together, which are believed to represent ocean currents, but no one now knows how they were used. When the canoes had left behind the last of the

Do they ever stop? The fact is that π is not a nice tidy number like 8, for example: if we represent 8 by a lump of sugar, π is more like a spoonful of treacle with a thin streamer dangling from it. Since you cannot wait all day for the streamer to stop running you bring the process to a halt by giving the spoon a twist. This is just what we do with π. The rough and ready twist that most people know gives the value $\frac{22}{7}$ to π; a much better and nearer value is 3·1416—more useful because it has the factors $3 \times 7 \times 8 \times 11 \times 0{\cdot}0017$.

Since ancient times, mathematicians have tried to get nearer and nearer to the true value of π and, in the sixteenth century, Van Ceulen spent most of his life calculating π to 35 decimal places. Those who hoped to find an exact figure were doomed to disappointment because π is not only *irrational*, it is also *transcendental* (sixth form words) and never terminates when expressed as a decimal.

When electronic computing machines came into use about ten years ago, it was not long before a machine was set the task of extending knowledge in respect of an approximation to π. The ENIAC machine determined π to 2,035 places in 1949, and the Editor of MATHEMATICAL PIE started the publication of this determination in Issue No. 18, May 1956, by printing the numbers along the bottom of the pages. Since 320 figures are printed in an average issue, the ENIAC determination would have been used up in seven issues. A new determination has been made, however, by Mr. G. E. Felton using the Ferranti Pegasus Computer which carried the evaluation to 10,000 places in 33 hours machine time. On an ordinary desk calculator, this work would have taken about a hundred years! New machines now being designed should do it in an hour!

Mr. Felton has kindly given permission for his determination to be used in MATHEMATICAL PIE and gives some interesting details of how it was done. He writes:

"The calculation was done on the Pegasus Computer at the Ferranti London Computer Centre on various weekends between August 1956 and April 1957. Pegasus is a medium-sized machine which does an addition or subtraction in about 300 microseconds; a multiplication in about 2 milliseconds and a division in about 5½ milliseconds. It has a store with a capacity of about 4000 numbers, each of 11 decimal digits and a sign. Internal operations are carried out in the binary scale, but all the conversions into and out of this scale are done by the computer itself. The formula used for the calculation was the following, due, I believe, to Klingenstierna:

$$\pi = 32 \text{ arc cot } 10 - 4 \text{ arc cot } 239 - 16 \text{ arc cot } 515.$$

The three arc cotangents were evaluated with the Gregory series:

$$\text{arc cot } x = \frac{1}{x} - \frac{1}{3x^3} + \frac{1}{5x^5} - \frac{1}{7x^7} + - - - - -$$

"For the value of 32 arc cot 10 about 5000 terms had to be evaluated, each to 10021 decimals; this took about 12 hours on the computer.

"I am now trying to check the value by using the formula of Gauss:

$$\pi = 48 \text{ arc cot } 18 + 32 \text{ arc cot } 57 - 20 \text{ arc cot } 239.$$

"This check is much more lengthy than the original calculation and has so far only reached 7733 digits. There is disagreement beyond 7480 digits and I am at present investigating this when I get the opportunity.

"I have also used a similar process to evaluate a number of logarithms to just over 1000 digits".

We feel sure all our readers are grateful to Mr. Felton for giving us an insight into this fascinating work and wish him all success in his researches.

NOTE.—Those readers not familiar with the "arc" notation should read arc cot x as "the angle whose cotangent is x; it is preferable to the alternative "$\cot^{-1} x$" for more than one reason.

J.F.H.

original, his presentation of the subject was successful in improving the teaching of the theory of numbers and in demonstrating geometry. The early Christian scholars lived too intense a religious life and their persecutions were too close for them to devote time to such a speculative subject as mathematics, so it is not surprising that the subject lay almost dormant until Christianity had become powerful.

One of the greatest of the Church scholars was Baeda, the Venerable Bede (c. 673–735), who has been called " the father of English learning ". His mathematical interests were in the ancient number theory, the calendar and the finger symbolism in number.

The next great European scholar in mathematics was Alcuin (735–804), who studied in Italy, taught in York and later became an abbot. He wrote on arithmetic, geometry and astronomy and his name is connected with a collection of puzzle problems.

After the death of Alcuin, the invasion of Britain by the Danes destroyed the security necessary for intellectual development and there followed a marked decay in British learning. I.L.C.

FUN WITH NUMBERS No. 5

From " Le Facteur X ".

(a) Put brackets in the following statement so that it is now true :

$$3 + 4 - 5 - 3 - 1 - 5 = 12.$$

(b) Can you justify the expression $a+b\times a+b+a\times b=122$ by inserting suitable brackets and choosing a and b from amongst the three numbers 3, 4 and 5?

STAMP COLLECTORS' CORNER No. 6

Belgium 1942,
1·75 fr. + 50c *dark blue.*

GERARD KREMER (1512–1594), who latinised his name to GERADUS MERCATOR, studied at Louvain and became a surveyor and instrument maker. He made and published surveys of Flanders, and also published maps of the world. His first world maps were based on Ptolemy's but his later maps were corrected to agree with the observations made by navigators. After charges of heresy he left Flanders and settled in Germany. In 1568 he brought out his navigational map in which the globe is represented in such a way that the compass bearing from one point to another can be measured directly from the map. This projection is still used for nearly all navigational maps. C.V.G.

PIE AND π

Little Jack Horner sat in the corner
Finding the value of π ;
The masses of digits
Gave his fingers the fidgets,
So he copied the figures from *Pie.*

New readers of *Mathematical Pie* are sometimes puzzled by the rows of figures at the bottom of each page and, from time to time, the Editor receives an enquiry as to what they represent. The answer is that these figures are part of an approximation to the value of π, a number of such importance in mathematics that its connection with the circumference and diameter of a circle is almost a sideline. Why are there so many figures?

23144 29524 84937 18711 01457 65403 59027 99344

South Pacific islands 1,500 miles of empty sea separated them from home. They continued on their course by keeping the wind on the starboard beam until the equator was crossed. Then the Sacred Calabash became their guide.

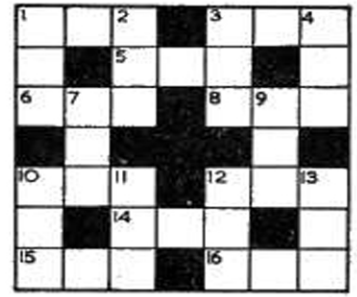
This instrument was made from a gourd over three feet in length, rather like an enormous coconut. The top had been removed, the inside cleaned out, and four holes, equally spaced below the rim, bored through the shell. When the Calabash was filled with water and held upright so that the water was level with the four holes the rim was horizontal. The four holes were so placed that in Hawaii an observer looking through any one of the holes could just see the Pole Star over the opposite rim. During the long journey northward observations were made of the Pole Star. When, at last, it could be seen on the rim of the Calabash course was altered to the west, and the canoe continued on the latitude of Hawaii, frequently checking position, until the peaks of Mauna Loa and Mauna Kea rose above the horizon to guide the voyagers back to harbour. C.V.G.

CHARLIE COOK

(From the Mathematics Student Journal)

$$\frac{17^3+7^3}{17^3+10^3} = \frac{17+7}{17+10}$$

SENIOR CROSS-FIGURE No. 26



ACROSS

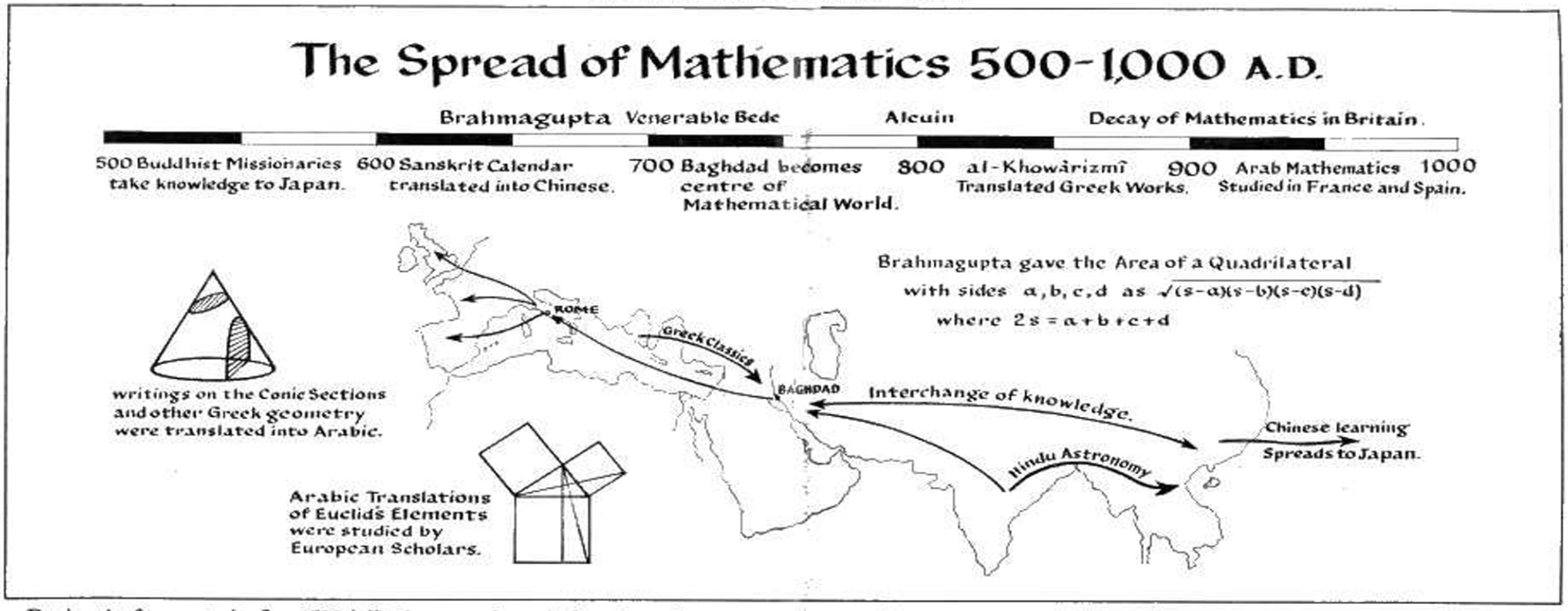
1. Median AX of triangle ABC when AB = 10, BC = 12, CA = 8.
3. 5% Compound Interest on £2 for 2 years (in £).
5. Smaller of 2 consecutive odd numbers whose squares differ by 480.
6. Interior angle of regular polygon with 15 sides.
8. 3 figure number such that the middle digit is the average of the first and last digits.
10. 20y (see 11 dn.)
12. Volume in cubic inches of right circular cone 1 ft. high and base-radius 3.5 ins.
14. $\dfrac{125^{\frac{1}{3}}\times 32^{\frac{4}{5}}}{4\sqrt{25}\times 27^{-\frac{1}{3}}}$
15. H.C.F. of $6x^2-11x-2$ and x^2-4 when $x=8.73$.
16. A number divisible by 29, the product of whose digits is 70 and sum 14.

DOWN

1. Reverse of total surface area, in sq. ins., of cone (see 12 ac.)
2. $0.48\ \sqrt{\left\{(0.8)^2+31.25\times 0.072\right\}}$.
3. See 7 dn.
4. y^2+10 (see 11 dn.)
7. Twice 3 dn.
9. $\dfrac{B}{C}$ as a decimal, if A is 20% more than B and 25% less than C.
10. 8 ac. + 12 dn.
11. 0.1% of prime root of $y^2-25y+46=0$.
12. 36th term of A.P. whose 3rd term is 8 and whose 7th term is 4 times the second term.
13. $\frac{3}{4}$ of 16 ac.

Check clue : Sum of all the digits inserted is 155. I.L.C.

68299 89487 22658 80485 75640 14270 47755 51323



During the five centuries from 500 A.D. the general trend of mathematics was westward rather than towards the East, though there was quite considerable progress in the Orient.

The increasing amount of trade between the Middle East and the Orient strongly influenced and developed the art of calculation, while the eastward travelling pilgrims and the movement of armies gave rise to an exchange of knowledge relating to abstract mathematics and astronomy.

Much of the mathematical work in China at this time was connected with the improvement of the calendar, and it was during the 7th century that a Sanskrit calendar was translated into Chinese. Following a visit to India between 629 and 645, the Chinese mathematician Hüan-tsang spent the rest of his life translating Hindu mathematical scripts.

During the 8th century, the interchange of Arab and Chinese ambassadors resulted in a further and wider exchange of knowledge. The friendship of these two countries was particularly strong during the reign of Harun-al-Rashid (well known from the Tales of the Arabian Nights), when Baghdad was rapidly becoming the centre of the mathematical world.

Japanese mathematical development was strongly influenced after the introduction of Buddhism in 552, and it was about two years after this that Japan adopted the Chinese system of chronology. From then on Japanese intellectual life was almost completely the result of Chinese influence. Chinese measures were adopted, an observatory was founded and, in 701, a

university system was established in which nine Chinese works were specified for students of mathematics.

The mathematics produced in India during this period was a mixture of brilliant and very ordinary works, but it is worth noting the contributions of Aryabhatas the Elder, Varahamihira the astronomer, Brahmagupta and Mahaviracarya. The first of these produced a collection of astronomical tables, several works on arithmetic and showed a knowledge of quadratic equations and indeterminate linear equations. The most prominent among them was Brahmagupta, who lived during the 7th century. At the age of 30 he wrote an astronomical work of 21 chapters entitled Brahmasiddhanta. The rest of his work included areas in arithmetic, the application of algebra to astronomy and indeterminate equations.

The greatest encouragement in the study of mathematics was to be found in Baghdad, where Hindu astronomy and mathematics were studied and developed by many scholars. The works of Brahmagupta were translated and the classics of Greek mathematics were introduced into the court of the Caliphs.

It was through the work in Baghdad that mathematics spread to the west, where newly civilized countries were slowly assimilating Roman culture.

The mathematical works of Boethius, a Roman citizen, were held in high regard in the monastic schools of the west. Though his work was not