M500 NEWSLETTER No. 13 May 1974

Editor: (Mrs) Marion Stubbs, Southampton

ARE WE TYPICAL - Sinbad. (This is our old friend of the Tall Ship.)

As a relief from being put through the Hoops each month by the hard mathematicians, I wonder if M500 students might like to cogitate on a more human problem? At my OU induction meeting, the Regional Director and others made several remarks similar to the quotation of J. J. Sylvester (M500/12), as a result of which I was much exercised last year to see if I could identify any such species as a mathematical stereotype. By this I mean: is there any subset of observable characteristics and behaviour possessed by mathematicians and not by students of other Faculties? I believe there is, and this belief was cemented when I attended both a Maths and a Technology Summer School last year, within a space of three weeks at the same University. There was a discernible difference both in the students and in the collective “atmosphere”. What I am asking is not a frivolous question since we know the creed of the OU is openness without regard to previous qualifications. However, without any previous record how is a counsellor to advise an applicant whether or not he has the potential to succeed. Naomi’s statistics tell us that the initial counselling interview cannot have served applicant maths students very well, so any help we can give them in recognising a mathematical type must surely be welcome. Or, at a more philosophical level, we know that mathematicians discover and manipulate mathematical objects. If we could define the personality traits of the mathematicians, it might throw some light on this process of discovery, or even more important, it may indicate what they are unlikely to discover through the shackles of their own behaviour patterns. At this point I have the unenviable task of making a first, tentative definition of a mathematical stereotype, as I see him. Please, no M.C.P. reactions to point 1 - like Sgt. Friday, all I want is the fact, ma’am.

1) A mathematician is more likely to be male than female. Is this inherent, i.e. do women lack the necessary logic, or is it a cultural thing and considered unfeminine?

2) Mathematicians are vertical thinkers rather than lateral. For this reason the long-haired youth from the Art College (now here is a stereotype for you!) is

more likely to make a breakthrough in creative design, even though the mathematician will have to make it workable.

3) Mathematicians have little sense of humour. If you tell them a joke, they consider it for a long time, possibly to test whether it is a joke, by which time it is hardly worth laughing.

4)a) Mathematicians are essentially non-communicative. Try counting heads on the various committees and see how poorly we are represented.

4)b) As a corollary, mathematicians seek to isolate themselves from contact with the real world by inventing more and more esoteric modes of expression. They rationalise this by saying that English will not serve their special purpose, yet English serves well enough to communicate their special language as a metalanguage.



5) Applied mathematicians are a good fit to this stereotype. Pure mathematicians tend to have some of the characteristics of an Art student.

6) I have been unable to identify any physical characteristics, i.e. whether short or fat or blond or otherwise.

Now I know that M500 readers are not a representative subset of all mathematicians, in that they are both associative and communicative and so contradict points 4a and 4b, however, what about all the other mathematicians that we know? What do you think are the observable characteristics that all good mathematicians possess?

Incidentally, if you are not familiar with my choice of adjective in the opening paragraph, a ‘hard’ mathematician is one who is, by example, hell-bent for M321 and above, while a ‘soft’ mathematician would lean more towards AM289.

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Ed: To start the ball rolling, I will offer, tentatively, that Art applicants do not necessarily look like the stereotype which they conform to after a few months in the 'atmosphere’

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Roger Claxton - M202

Has anybody come across WFF'N PROOF "The Game of Modern Logic"? I have just bought a pack in total innocence, and have discovered there are 21 games described in the rule book, which is the size of a normal paperback (170 pages!) It looks fascinating, but may well have to wait until the end of the Academic year! For information I quote: 'A 21-game kit that teaches propositional logic and develops habits of careful reasoning. The beginning games ... teach WFFs ... . The remaining games deal with rules of inference, logical proofs and the nature of formal systems.' It is American and there are many other games in the series, including games on Set Theory, Equations and Configurations. This is not a sales pitch, but these games are certainly different. If anyone has any experience of them I would be interested to hear. I will provide information myself when I have mastered the rule book!

Has anybody got a solution to the machine construction of SAQ 13 Unit 9 M202 (Finite State Machines)? I have spent some time attempting a construction but have got nowhere. I would be interested to see a solution. May I also confirm Peter Weir's experience of Units 4 and 5. It looks as if Units 11 and 12 are going to be worse but at least we can all go down together.

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MATH-QUOTE - Ron Davidson

Mathematics is not the discoverer of laws, for it is not induction; neither is it the framer of theories, for it is not hypothesis; but it is the judge over both, and it is the arbiter to which each must refer its claims; and neither law can rule nor theory explain without the sanction of mathematics.

Benjamin Pierce

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CONTRADICTION IS A CONTINUOUS FUNCTION - Datta Gumaste

Consider the following situations:

1) Husband asserts P where P is some proposition.

Wife retorts not P.

On another occasion wife asserts P. Husband spontaneously declares not P.

They both regard it as their function to continuously contradict the other.

The name of the game is MARRIAGE.

2) A leader makes a number of assertions P, Q, R, ... . His opponent forcefully denies them all. He shouts not P, not Q, not R, ... .They continuously contradict each other. The name of the game is POLITICS.

3) People accuse a person, say X, for some crime. Prosecuting counsel makes a gallant speech asserting S, T, U, ... . The defence counsel cleverly and brilliantly attempts to show not S, not T, not U, ... .The name of the game is LAW.

We are surrounded by plenty of such situations. We will provide a mathematical proof of the underlying theme of such situations.

THEOREM: Contradiction is a continuous function.

Let $P$ be a set of propositions.
Let $A$ be a topology defined on $P$.
$A = \{\emptyset, T, F, P\}$.
$T$ is the set of all true propositions,
$F$ is the set of all false propositions.

To verify that $A$ is a topology we have to see that $A$ satisfies the four topology axioms.

Now, let $X$ be any non-empty set, and $T$ be a collection of subsets of $X$ such that:

1. $X \in T$.
2. $\emptyset \in T$.
3. The intersection of a finite number of elements of $T$ is in $T$.
4 . The union of any elements of $T$ is in $T$.

$T$ is called a topology on $X$, $X$ is called the underlying set, and members of $T$ are called open sets.

Now, returning to our set $P$ which is the underlying set, we have to show that $A$ is a topology on $P$. To do this we must show that $A$ satisfies the four axioms. So let us do it:

1. $P \in A$
2. $\varnothing \in A$
3. Intersection defined on $A$ is closed, e.g. $T \cap F = \varnothing$, $F \cap P = F$, etc.
4. Union defined on $A$ is closed, e.g. $\varnothing \cup T = T$, $F \cup P = P$, etc.

So $A$ is indeed a topology, as claimed.

Consider the function ‘CONTRADICTION’ on $P$ to $P$.

Let CONTRADICTION = $C$.

$$C\colon a \to \text{not } a.$$

Thus, if $a$ is true, not $a$ is false, and if $a$ is false, not $a$ is true. (Recall M100 Unit 11 Logic (1)). We claim that $C$ is continuous. But what are continuous functions?

Given topological spaces $(X, T)$ and $(Y, S)$, a function $f$ from $X$ to $Y$ is continuous if and only if for every open subset of $Y$ its inverse image is an open subset of $X$.

Now once we have clarified the meaning of inverse image, we can proceed to prove that contradiction is a continuous function.

Let $f\colon A \to B$ be a given function. We know that for each subset $T$ of $A$, $f(T)$ is the set of all $f(x)$ such that $x \in T$.

Suppose $S$ is a subset of $B$. A subset $R$ of $A$ whose elements are all $x \in A$ such that $f(x) \in S$ is called the inverse image of $S$ and is denoted by $f^{-1}(S)$.

Now to show that $C$ is continuous we must show that the inverse image of every open set in $A$ is open. But this is easy. Observe:

$C^{-1}(\varnothing) = \{a\colon C(a) \in \varnothing\} = \varnothing$,
$C^{-1}(P) = \{a\colon C(a) \in P\} = P$,
$C^{-1}(T) = \{a\colon C(a) \in T\} = F$,
$C^{-1}(F) = \{a\colon C(a) \in F\} = T$.

So we have proved that CONTRADICTION is a continuous function.

Having proved the 'fundamental theorem' (!) in the theory of continuous contradictions, or the game of living as some will say, we must leave the non-mathematicians and users of mathematics to continue to contradict each other, including themselves (!!). For they are now guaranteed a firm mathematical base (!!!)

As for the mathematicians, it is clear that they and babies continue to live in the world of non-contradiction. This assertion is either trivial or profound depending on the way you look at it, and hence its proof must be left to the reader (!!!!)

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AN OAP VIEW OF THE OU - George Dngley, M202

As an A-year student I have nostalgic memories of those early days of 1970 when the first advertisements of the OU began to appear, urging the ignorant, the disabled and the insane to join. It was open to all. It was just what I needed. I was ignorant, aged and deteriorating rapidly. I was totally disabled (Class of Jean Posthuma, *Sesame* March 1974). I applied.

Back came the literature. Referee? OK. Academics? English non-existent. No formal education from the age of twelve. Date of birth - April 16th 1907.

Several days later came the notice of receipt. Several weeks later - ‘Please attend at 2.30 pm for interview with Mrs. Hall.’ I'm there before time. Mrs. Hall arrives at 2. 45pm. We clear the books, papers and periodicals from the desk and chairs. We sit down exhausted. Mrs. Hall recovers first. “What was it decided you to take M100, Mr. Dingley?” “I like Maths”, I replied. After a ding-dong battle from which we both emerged triumphant she said: “Right, Mr. Dingley. I think you will be all right.”

Three weeks of anxiety, excruciating to the memory, passed, and the letter arrived. I was a member of the OU Student Class. With it came the cost. Oh Lord, where am I to raise that amount? Around about Christmas glossy units, huge envelopes containing slips of paper and reams of information began to arrive. So did the notice of the local Induction Meeting.

The students were the usual crowd - 70% teachers. Here and there a grey head. The number of ladies surprised me. Remember my background? I struggled with the units, attended tutorials, gradually became familiar with both. I was extremely diffident in those days. Couldn't write (I could spell.) All the questions were ambiguous to me. I usually got the wrong meaning. 4.45 was the mark I obtained for my first TMA. I almost sent it back, telling him that he had made a mistake. That's what the others did (the teachers), getting an upward revision. I didn't - he would have knocked it down!

I received some ribbing, a great deal of understanding, some set-downs, but I've learnt and am still learning. I'm getting what I joined the OU for - a first class education. The degree is of secondary importance.

It was hard going, and it still is. Memory becomes erratic; the ability to concentrate deteriorates with age. I've enjoyed every moment of it, even the stomach pains from eating too rich food at Summer School. I have lived too long with death looking over my shoulder to forego my humour. I do not laugh at other people, not if I can help it. I prefer to laugh with them and at myself and my foibles.

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MATH-QUOTE - Ron Davidson

Having to evaluate an expression of the form 0/0 is the penalty you have to pay for over-idealisation and is an indication that the treatment of the problem is at variance with nature!

Prof. Sir C. Inglis - *Applied Mechanics for Engineers*

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Tom Dale - M231, MDT241

Can M500 influence anyone to get a better 'algorithm' on the go for making up errata lists? It irks me to count 20 lines only to find the amendment has to be made to the ‘first line of para 3’ or ‘line following equation 5’ or some easily identified line, (especially since it's not always clear whether the footnotes or captions are included in the count, and whether fractions are one line or two.) And I think, too, it would be better to be told to ‘amend --- to --’ or ‘add ---- after ----’ rather than merely print the correction without indicating where the error is.

Anything which saves even a milliday is welcome!

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Willem van der Eyken - M201, MDT241

What I really need is a sympathetic, thick and available M201 student who happens to understand all the bits that give me endless pain, but who desperately needs my help on the rather small areas which I appear to understand. You wouldn't have such a rare student tucked amid your sheaves, would you?

It would be useful to discuss the problem of timing of M100 for those (many?) new students who never did calculus in their schooldays (like myself), who found themselves with Integration one week and Differentiation the next (or preceding) week. The result of this is that some of us continue to have great trouble with calculus, and have never really mastered the Leibniz notation, having been 'brought up' on OU maths. It seems to me that the Faculty could make a big inroad into the high drop-out and failure rate of mathematics at OU if (a) they prepared a booklet on elementary calculus and sent it out to students in November so that people had time to study it at leisure and (b) if they sent out the first two or three units of a course in December, so that busy people could make a running start to their course. I have personally always bought the first two units months before course began, and found this a considerable help, as well as overcoming that 'dead' period between the exam and February, when the process starts up again.

I think there is a further service we could render M100 students in providing them with past exam papers and mock exams. I remember that my colleagues, who were less cunning than I seemed to be, had great difficulty in obtaining such copies but by now there must be quite a collection of these about, and perhaps MOUTHS could make these available. Equally, people like myself would of course like to obtain copies of as many M201 mock and exam papers as possible, including, say, Summer School 'tests'. Is there anything in this? I have quite a batch of M100 exam material available.

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Ed: The M231 textbook 'disallows' Leibniz notation which may comfort others of the fog-brigade. Why can't the Director of Marketing simply SELL us the old exam papers and Summer School materials? They are now in circulation, so not ‘classified’.

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Group Determinants

Those of you who have worked through M201 may have noticed that the course material does not describe quick methods of evaluating determinants. But you will probably have noticed that

$$\det \begin{bmatrix} a & b \\ b & a \end{bmatrix} = a^2 - b^2 = (a + b)\,(a - b). \qquad (1)$$

There is, of course, a trick which helps in the evaluation of determinants, and this trick makes it obvious where the first factor of the right hand side of (1) comes from. Adding multiples of one column to another does not change the value of the determinant, while multiplication of a column by a factor *f* multiplies the value of the determinant by *f*. So we have

$$\det \begin{bmatrix} a & b \\ b & a \end{bmatrix} = \det \begin{bmatrix} a+b & b \\ b+a & a \end{bmatrix} = (a + b) \det \begin{bmatrix} 1 & b \\ 1 & a \end{bmatrix}.$$

Kid’s stuff, you may be thinking. But what about the other factor of (1)? If you think you know where it comes from, try

$$\det \begin{bmatrix} a & b & c \\ b & c & a \\ c & a & b \end{bmatrix} = K.$$

Obviously there is a factor $a + b + c$, but what about the others? If you have seen this game before, or if you are smart enough, you may spot that the trick is to take a complex (i.e. primitive) cube root $w$ of 1. Then,

$$\text{col } 1 + w \text{ col } 2 + w^2 \text{ col } 3 = (a + wb + w^2c) \begin{bmatrix} 1 \\ w^2 \\ w \end{bmatrix}$$

so there is a factor $a + wb + w^2c$. A similar argument tells us that there is another factor $a + w^2b + wc$, so

$$K = (a + b + c)\,(a + wb + w^2c)\,(a + w^2b + wc).$$

(There are no other factors, and no constants. Why not?)

So what? Well clever 19th century mathematicians realised that there were some general results lying about to be proved here. The determinants we have looked at are examples of *group determinants*. Take a group $G$, and write down its multiplication table. Regarding each element of the group as an indeterminate, take the determinant. (!) (Thus the two we have been looking at are the group determinants of the cyclic groups of two and three elements). It is not hard to prove.

<u>Theorem</u> The group determinant of any of any cyclic group is a product of linear factors $\sum_{i=1}^{N} \zeta^i x_i$, where $x_1, x_2, ..., x_n$ are the group elements, regarded as indeterminants, and $\zeta$ is an $n$th root of 1.

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This result leads to a branch of group theory called representation theory, and if you are interested, you will find this and more general results in books on the subject. But I am just going to ask you what happens in a special case where the group is not abelian. The simplest non-abelian group is the symmetric group on three symbols. Let use M100 notation (unit 30 p.36). What is

$$\det \begin{bmatrix} e & R_1 & R_2 & S_1 & S_2 & S_3 \\ R_1 & R_2 & e & S_3 & S_1 & S_2 \\ R_2 & e & R_1 & S_2 & S_3 & S_1 \\ S_1 & S_2 & S_3 & e & R_1 & R_2 \\ S_2 & S_3 & S_1 & R_2 & e & R_1 \\ S_3 & S_1 & S_2 & R_1 & R_2 & e \end{bmatrix} ?$$

Obviously there is a factor $(e + R_1 + R_2 + S_1 + S_2 + S_3)$. Less obviously, there is a factor $(e + R_1 + R_2 - S_1 - S_2 - S_3)$. What is the other factor? Well, it is

$$-(e^2 + R_1^2 + R_2^2 - S_1^2 - S_2^2 - S_3^2 - eR_1 - R_1 R_2 - R_2 e + S_1S_2 + S_2S_3 + S_3S_1)^2.$$

I find this very remarkable. For the general theory, you must consult the works of Frobenius or books on representation theory. Meanwhile, can anyone find an elementary proof of this factorisation which does not multiply everything out and factorise it, yet which does not appeal to any result not in M100 or M202? If a short solution can be found, it will be published here.

John Peters (Staff Tutor in Maths, Open University, Yorkshire)

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KNIT YOURSELF A KLEIN BOTTLE - supplied by George Russell and reprinted, with permission, from *Manifold*, published at the University of Warwick.

Materials: 3 oz double knitting wool. 4 needles No. 10

Using 3 no. 10 needles cast on 90 sts, 30 to each needle.

Knit straight until work measures 4 inches.

At beginning of next round knit 90 sts, turn and purl 90 sts, so as to leave a hole in the work.

Repeat these two rows until hole measures 1½ inches.

Join round on the next row.

Decrease one stitch at both ends of each needle on every alternate round until 27 sts remain, 9 on each needle.

Knit straight for a further 12 inches.

Pass work through hole.

Increase one stitch at each end of every needle until there are 90 sts again, 30 to each needle.

Knit straight for 6 rounds.

Using the fourth needle, take one stitch from needle and one stitch from cast-on edge and knit together.

Repeat for 90 sts.

Cast off.

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PREVIEW OF A NEW COURSE - Graham Flegg, AM289 Course Team Chairman

I am delighted to have been asked to give M500 some advance information on the History of Mathematics course, AM289, which is available in 1975. This is an inter-faculty course. There are no prerequisites, although it is expected that most of the students undertaking this course will have previously read either A100 or M100. Eleven units will be devoted to a general background study of topics in the history of mathematics; these units will be supported by TV programmes and draft outlines of the intended content of the programmes follow. These are not final, however. We are using famous mathematical historians in the TV programmes (all of which are being made as colour films), and we hope to have van der Waerden, Boyer, Kline, etc. in the various films.

List of film topics for the general section of the course

1. Numbers and Counting
The development of the awareness of numbers in primitive times. Development of number words and symbols. Comparison of Babylonian, Egyptian, Mayan, etc. number systems and systems of calculation. Present-day evidence from primitive tribes. Early development of number sense in children. History of Hindu-arabic numerals.

2. Number Systems
The development of the present-day real number system. Numbers and measurement in early times. Greek discovery of irrationals. Early fractions. Development of the decimal number system. Other number systems in ancient and modern times.

3. Greek Mathematics
The Pythagoreans. The three classical problems. Development of the concept of proof. Greek ‘philosophy’ of numbers. How the problems were solved.

4. The Parallel Axiom
The axiom in Euclid. Greek disquiet at the parallel axiom and infinite lines. Arabic interest. Saccheri’s quadrilateral and the parallel axiom. Legendre (links with mathematics of the French Revolution). Gauss, Bolyai and Lobachevsky. Non-Euclidean geometry and its impact on man’s view of the nature of space. Interest of geodesics. Riemannian geometry. Connection between matter and space leading to relativity and nuclear physics.

5. Projection
Greek conic sections. Pre-Renaissance art. Perspective in Renaissance art. Projection and section. Development of projective geometry. Mathematical concepts involved. Map projection in ancient and modern times. Modern geometries.

6. The Calculus
Foundations in Greek mathematics; method of exhaustion. Precursors of Newton and Leibniz. Newton and Leibniz and the controversy over priority. Difference of notation. Effects of the controversy. The calculus on a rigorous

footing. The concept of function and links with analytical geometry.

7. Coordinate Geometry
The relation between geometry, arithmetic and algebra. Descartes and Fermat. Geometry of many dimensions. Links with calculus. Complex numbers and the Argand diagram. Geometric transformations. Systems of axes.

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8. The Solution of Equations
Equations in ancient times: Babylonian solutions of quadratic and cubic. Relation to geometry in Greek times. Diophantus. Cardan and Viète. Equations in arabic and Hindu mathematics. Graphical methods.

9. Algebra in Modern Times
The development of linear algebra. Concept of a vector and a vector space. Cayley, Hamilton and Sylvester. Vector space transformations: Matrices. Rise of abstract algebra. Effect on modern teaching of mathematics.

10. Paradoxes
Discussion of a selection of the great paradoxes in mathematics. Zeno's paradoxes. Problems arising from 'infinity'. Infinite sets. Paradoxes in the foundations of mathematics. Russell's paradox. Gődel.

11. Mathematics and the Arts
A study of the impact of mathematical ideas in architecture, painting, music, philosophy, etc. Early mathematical designs. Group theory and symmetry: the work of Escher.

In addition to the general section of the course, there will be a choice of one from two special areas of study equivalent to five units, which will be specially prepared by external consultants. The choice will be from:

Origins and Development of the Calculus
Counting, Numerals and Calculation

The former of these is intended for students who have completed M100 or who have some familiarity with the calculus, although either option is available to all students. Students without at least M100 or MST281 background in the calculus will find the going tough if they elect to do this calculus option. The course is concerned specifically with the development of mathematical ideas, and it does not involve committing to memory large numbers of dates. Even names have been kept to a minimum. The latter option is intended for the general liberal arts student. All students will, however, have an entirely free choice.

Each special area of study unit is accompanied by a radio programme, for the most part recorded by the consultants who have written the units.

The general part of the course (11 units) is almost entirely set book reading accompanied by notes and exercises. The two special areas consisting of five units are self-contained and complete in themselves.

There will be no summer school, but we are hoping to have half-day (or, possibly, full-day) tutorial sessions at weekends, and we are also hoping to collaborate with the British Society for the History of Mathematics so that they will organise additional day or weekend schools which are relevant to the course.

I think the course should prove very attractive to mathematics students, (possibly especially those who teach mathematics or who are generally interested in background.) There are four set books for the course:

A History of Mathematics: Boyer - Wiley
Mathematics in Western Culture: Kline - Pelican
Mathematics and Mathematicians: Dedron and Itard - Transworld
Evolution of Mathematical Concepts: Wilder - Transworld

All these books will be in paperback form by 1974.

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For details of the British Society for the History of Mathematics, write to Dr. J. Dubby, Dept. Of Mathematics, Polytechnic of the South Bank. (Sub is £1 per annum currently)

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MORE SOLUTIONS TO THE LADDERS OF PROBLEM CORNER No. 11

2. 24.9207 or 16.7021 (Dennis Hendley).

4b. (Ladder on cylinder)
6.775 or 29.225 (Bill Shannon). Solution very neat and easy, using radius parallel to wall, radius perp. to wall, radius perp. to ladder, and line from top of ladder to centre of cylinder. Then congruent triangles give an equation in $r$ and $L$.

And this must surely be the last word? - From Norman Thomson (M251 Course Tutor)

2. 16.702116225 or 24.92066038.
3. 7.563110117 or 29.03100696.

4a. $x = 10.36622518$, $y = 28.15211139$ or
$x = 26.5037304$, $y = 14.055329057$.

4b. 6.77502784 or 29.22497216.

SOLUTIONS TO PROBLEM CORNER No. 12

1. $2^9 \times 59 = 512 \times 1953125$ (Bill Shannon, Michael Gregory, M. Stubbs, Eddie Kent).

2. No solutions yet offered.

3. $P(r) = \dfrac{6 - |r - 7|}{36}$. (B. Dowding and P. Goble (staff), B. Shannon, G. Dingley, M. Gregory, Marjorie Kerr).

PROBLEM CORNER No. 13

1. Two circular cylinders of unit radius intersect at right angles. What is the volume common to both cylinders? If that's too easy what volume is common to three cylinders of unit radius with axes mutually perpendicular? (M Gregory)

2. Find three positive integers, $a$, $b$ and $c$, all different, such that $a^4 + b^4 = c^5$ (with a little trickery it is not as difficult as it looks.) (Bill Shannon)

3. A further ladder problem: 20′ and 30′ ladders cross 10′ up in an alleyway. How wide is the alley? (Tom Dale)

4. Given the set of integers from 1 to 20 inclusive, find a subset of 9 integers (all different) such that no combination of any three of the 9 integers forms an arithmetical progression. (M. Stubbs - purloined without permission from '*Games and Puzzles*' No.23.)

If anyone is still working on Mastermind (Problem Corner 10), for which no solution has yet been offered, there is a two-page report on an experiment with children playing the game in '*Games and Puzzles*', No. 23 March 1974, available from major newsagents or from the Circulation Manager, Games and Puzzles, at 25p. (Sub. is £3 per annum). I have just discovered this magazine and wish someone had told me before. It can be highly recommended to all who take their puzzles, games, chess, scrabble, wargames, draughts, crosswords, crossnumbers and mathematical problems seriously.

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We now have 240 subscribers, still rising. Items for M500/14 are needed now. So far David Asche on Permutations and Michael Gregory on crystallography are promised. Hurry, folks, with your piece.

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