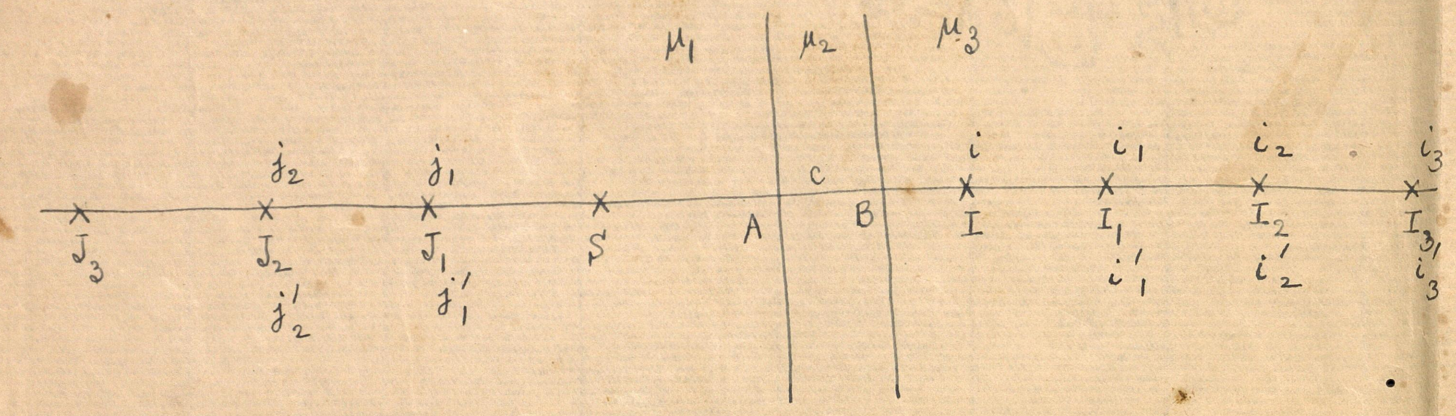
Page 424, Example 18.



$$V_{I} = \frac{m}{PS} + \frac{i}{PI} + \frac{i_1}{PI_1} + \frac{i_2}{PI_2} + \frac{i_3}{PI_3} + \cdots$$

$$V_{II} = \frac{m'}{PS} + \frac{i_1'}{PI_1} + \frac{i_2'}{PI_2} + \frac{i_3'}{PI_3} + \cdots$$

$$+ \frac{j_1'}{PJ_1} + \frac{j_2'}{PJ_2} + \frac{j_3'}{PJ_3} + \cdots$$

$$V_{III} = \frac{m''}{PS} + \frac{j_1}{PJ_1} + \frac{j_2}{PJ_2} + \frac{j_3}{PJ_3} + \cdots$$

$$\left.\begin{aligned} V_{I} &= V_{II} \\ \mu_1 \frac{\partial V_I}{\partial \nu} &= \mu_2 \frac{\partial V_{II}}{\partial \nu} \end{aligned}\right\} A$$

$$\left.\begin{aligned} V_{II} &= V_{III} \\ \mu_2 \frac{\partial V_{II}}{\partial \nu} &= \mu_3 \frac{\partial V_{III}}{\partial \nu} \end{aligned}\right\} B.$$

$AI = AS,\ BI_1 = BS,\ AJ_1 = AI_1,\ BI_2 = BJ_1,\ AJ_2 = AI_2,\ BI_3 = BJ_2, \ldots$

(A)

$$\frac{m+i}{PS} + \frac{i_1}{PI_1} + \frac{i_2}{PI_2} + \frac{i_3}{PI_3} = \frac{m'}{PS} + \frac{i_1'+j_1'}{PI_1} + \frac{i_2'+j_2'}{PI_2} + \frac{i_3'+j_3'}{PI_3} + \cdots$$

$$\mu_1 (m-i) \frac{\partial}{\partial \nu}\left(\frac{1}{PS}\right) + \mu_1 i_1 \frac{\partial}{\partial \nu}\left(\frac{1}{PI_1}\right) + \mu_1 i_2 \frac{\partial}{\partial \nu}\left(\frac{1}{PI_2}\right) + \mu_1 i_3 \frac{\partial}{\partial \nu}\left(\frac{1}{PI_3}\right) + \cdots$$

$$= \mu_2 m' \frac{\partial}{\partial \nu}\left(\frac{1}{PS}\right) + \mu_2 (i_1' - j_1') \frac{\partial}{\partial \nu}\left(\frac{1}{PI_1}\right) + \mu_2 (i_2' - j_2') \frac{\partial}{\partial \nu}\left(\frac{1}{PI_2}\right) + \mu_2 (i_3' - j_3') \frac{\partial}{\partial \nu}\left(\frac{1}{PI_3}\right)$$

(B)

$$\frac{m'+i_1'}{PS} + \frac{i_2'+j_1'}{PI_2} + \frac{i_3'+j_2'}{PI_3} + \cdots = \frac{m''}{PS} + \frac{j_1}{PI_2} + \frac{j_2}{PI_3}$$

$$\mu_2 (m'-i_1') \frac{\partial}{\partial \nu}\left(\frac{1}{PS}\right) + \mu_2 (i_2' - j_1') \frac{\partial}{\partial \nu}\left(\frac{1}{PI_2}\right) + \mu_2 (i_3' - j_2') \frac{\partial}{\partial \nu}\left(\frac{1}{PI_3}\right)$$

$$= \mu_3 m'' \frac{\partial}{\partial \nu}\left(\frac{1}{PS}\right) - \mu_3 j_1 \frac{\partial}{\partial \nu}\left(\frac{1}{PI_2}\right) - \mu_3 j_2 \frac{\partial}{\partial \nu}\left(\frac{1}{PI_3}\right).$$

$$\left.\begin{array}{l} m+i=m' \\ \mu_1(m-i)=\mu_2 m' \end{array}\right\} \quad \left| \begin{array}{l} i_1 = i_1' + j_1' \\ \mu_1 i_1 = \mu_2(i_1' - j_1') \end{array} \right| \begin{array}{l} i_2 = i_2' + j_2' \\ \mu_1 i_2 = \mu_2(i_2' - j_2') \end{array} \left| \begin{array}{l} \cancel{i_3 = i_3' + j_3'} \\ \mu_1 i_3 = \mu_2 \cancel{(i_3' - j_3')} \end{array} \right.$$

$$\begin{array}{l} m'+i_1' = m'' \\ \mu_2(m'-i_1') = \mu_3 m'' \end{array} \left| \begin{array}{l} i_2' + j_1' = j_1 \\ \cancel{\mu_2(i_2'-j_1') = \mu_3} \\ \mu_2(j_1' - i_2') = \mu_3 j_1 \end{array} \right| \begin{array}{l} i_3' + j_2' = j_2 \\ \mu_2(j_2' - i_3') = \mu_3 j_2 \end{array}$$

$$m' = \frac{2\mu_1 m}{\mu_1+\mu_2} \quad \Bigg| \quad m'' = \frac{2\mu_2 m'}{\mu_2+\mu_3} \quad \Bigg| \quad i_1 = \frac{2\mu_2 i_1'}{\mu_1+\mu_2} \quad \Bigg| \quad j_1 = \frac{2\mu_2 j_1'}{\mu_2+\mu_3}.$$

$$i = \frac{\mu_1-\mu_2}{\mu_1+\mu_2} m \quad \Bigg| \quad i_1' = \frac{\mu_2-\mu_3}{\mu_2+\mu_3} m' \quad \Bigg| \quad j_1' = \frac{\mu_2-\mu_1}{\mu_1+\mu_2} i_1' \quad \Bigg| \quad i_2' = \frac{\mu_2-\mu_3}{\mu_2+\mu_3} j_1'$$

$$i_2 = \frac{2\mu_2 i_2'}{\mu_1+\mu_2} \quad \Bigg| \quad j_2 = \frac{2\mu_2 j_2'}{\mu_2+\mu_3}$$

$$j_2' = \frac{\mu_2-\mu_1}{\mu_1+\mu_2} i_2' \quad \Bigg| \quad i_3' = \frac{\mu_2-\mu_3}{\mu_2+\mu_3} j_2'$$

$$\rho = \frac{\mu_1-\mu_2}{\mu_1+\mu_2}, \quad \rho' = \frac{\mu_3-\mu_2}{\mu_3+\mu_2}$$

$$\frac{(1-\rho')(1+\rho)m}{PS} + \frac{(1-\rho')\rho\rho'(1+\rho)m}{PJ_1} + \frac{(1-\rho')\rho\rho'\rho\rho'(1+\rho)m}{PJ_2}$$

$$= m(1-\rho')(1+\rho)\left\{\frac{1}{PS} + \frac{\rho\rho'}{PJ_1} + \frac{(\rho\rho')^2}{PJ_2} + \cdots\right\}$$

$$SJ_1 = AJ_1 - AS = AI_1 - AI = SI_1 - SI = 2(SB - SA) = 2BA = 2c.$$

$$\frac{1}{PS} = \int_0^\infty e^{-xt} J_0(yt)\,dt, \quad \frac{1}{PJ_1} = \int_0^\infty e^{-(x+2c)t} J_0(yt)\,dt,$$

$$\frac{1}{PJ_2} = \int_0^\infty \cdots\cdots$$

$\therefore$ In the given example, $\mu_1 = \mu_3 = \mu$, $\mu_2 = 1$; $\rho = \rho'$.

$$\therefore \quad \Omega = m(1-\rho^2)\int_0^\infty \frac{e^{-xt} J_0(yt)}{1-\rho^2 e^{-2ct}}\,dt.$$

4/9

5/9/78 – Tuesday – 7.30 P.M. – Ramana Maharshi [illegible]

6/9/78 – Wednesday – 5.30 P.M. – Vidhana Soudha

There can be no [illegible] my [illegible]

no

~~Rough~~

(alternately a & c [illegible] & rows)

(1) Fig. 262 on p. 165 of Andrews – same as my Fig. 108 (n)

(2) ~~Fig. 261, p. 165 of Andrews (neither a nor n)~~ ② Fig. bottom Fig. p. 28, Bk. 21. (n) ~~(2 odd, 4 even, 2 odd, 2 even, 2 odd, 2 even)~~

2o, 2e, 2o
2o, 4e, 2o
2e, 4o, 2e

(3) Fig. 95 ~~[illegible]~~, p. 43, Andrews (associated) ✓ 20, 2e, 20, 2e replace (1, 7, 6, 4) by (1, 3, 2, 4)

(4) ~~Fig.~~ Lower Fig. p. 23, Bk. 21 (Cammann's form of Narayana (associated). ~~both same form~~ 40, 4e, 4e, 40

This is not Cammann's form

(5) Lower Fig. p. 27, Bk. 21. (n) ~~or Fig. p. 23, Bk. 21 (a) both same form~~

(6) Finally Narayana's Q_2, Q_4 even & Q_1, Q_3 odd (neither a nor n) ← see Sleeping [illegible]

2 associate
3 normal
1 neither a nor n.

$$\frac{1}{\pi} = \frac{1}{1^2}\left(\frac{1}{2}\right)^2 + \frac{2}{3^2}\left(\frac{1\cdot3}{2\cdot4}\right)^2 + \frac{3}{5^2}\left(\frac{1\cdot3\cdot5}{2\cdot4\cdot6}\right)^2 + \frac{4}{7^2}\left(\frac{1\cdot3\cdot5\cdot7}{2\cdot4\cdot6\cdot8}\right)^2$$

$$\frac{2}{\pi^2} = \frac{1\cdot3}{1^3}\left(\frac{1\cdot1}{2\cdot1}\right)^4 + \frac{2\cdot7}{3^3}\left(\frac{1\cdot3}{2\cdot4}\right)^4 + \frac{3\cdot11}{5^3}\left(\frac{1\cdot3\cdot5}{2\cdot4\cdot6}\right)^4 + \cdots$$

1,

0 1, 2, 6, 7
7 8, 9, 15, 16
22 23, 24, 28, 29
29 30, 31, 37, 38

1, 37, 31, 7
29, 9, 15, 23
16, 24, 28, 8
30, 6, 35, 2

0 | 1, 3, 10, 12
4 | 5, 7, 14, 16
6
10

114
146
260

122
122
138 260
138

Fig. 119 quarter [illegible]

40 + 43 + 16 + 3 + 32 + 19 + 56 + 59 = 268
40 + 62 + 56 + 22 + 32 + 6 + 16 + 46 = 280 ✗
40 + 15 + 35 + 12 + 33 + 10 + 38 + 13 ✗

A	1	3	2	4	5	7	6	8
A'	8	6	7	5	4	2	3	1
A'	8	6	7	5	4	2	3	1
A	1	3	2	4	5	7	6	8
A	1	3	2	4	5	7	6	8
A'	8	6	7	5	4	2	3	1
A'	8	6	7	5	4	2	3	1
A	1	3	2	4	5	7	6	8

+

0	56	56	0	0	56	56	0
16	40	40	16	16	40	40	16
8	48	48	8	8	48	48	8
24	32	32	24	24	32	32	24
32	24	24	32	32	24	24	32
48	8	8	48	48	8	8	48
40	16	16	40	40	16	16	40
56	0	0	56	56	0	0	56

=

1	59	58	4	5	63	62	8
24	46	47	21	20	42	43	17
16	54	55	13	12	50	51	9
25	35	34	28	29	39	38	32
33	27	26	36	37	31	30	40
56	14	15	53	52	10	11	49
48	22	23	45	44	18	19	41
57	3	2	60	61	7	6	64

~~40 + 43 + 4 + 15 + 32 + [illegible]~~

A + a, A + b, B + c, A + d
A + a, B + b, B + c, B + d
B + a, C + b, C + c, C + d
C + a, D + b, D + c, D + d
D + a, D + c, D + b, A + d
A + a, D + c, B + b, B + c
C + a, [illegible]
D + [illegible]

✗ 17, 10, 27, 60, 5, 38, 55, 48
49

1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1
8	7	6	5	4			
1	2	3	4	5			
1	2	3	4	5			
8	7	6	5				
8	7	6	5	4			
1	2	3	4	5			

0	56	56	0	0	56	56	0
8	48	48	8	8	48	48	8
16	40	40	16	16	40	40	16
24	32	32	24	24	32	32	24
32	24	24	32	32	24	24	32
40	16	16	40	40	16	16	40
48	8	8	48	48	8	8	48
56	0	0	56	56	0	0	56

1	58	59	4	5	62	63	8
16	55	54	13	12	51	50	9
19	44	42	24	17	47	45	22
30	37	39	25	32	34	36	27
35	28	26	40	33	31	29	38
43	20	18	48	41	23	21	46
56	15	14	53	52	11	10	49
57	2	3	60	61	6	7	64

(2, −1), (1, −2), (−2, 1), (−2, [illegible])
(−2, 1), (−1, 2), (2, 1)

2 + 28 + 63 + 37
64 + 38 + 1 + 27 = 260

31 + 60 + 34 + 5
36 + 7 + 29 + 58 = 260.

1, 2, 3, 4, 5, 6, 7, 8
2, 1, 4, 3, 6, 5, 8, 7

44 + 43 + 45 + 55
51 + 41 + 47 + 53

Physical Math LI

The question whether q_i has any meaning beyond the limit ~~n~~ of our observations is of no consequence to our practical problems.

Coming back to "Dust thou art, ~~and~~ to dust returneth"; if mathematics is a tool to investigate physical reality, "computer mathematics" is all that we need (for describing physics). All quantities used in this manipulation always exist — including the integer zero. Every number has a binary representation, and finite integers and decimal fractions having a finite number of decimal places are all that we need. Any mathematical equation can be solved by a computer, ~~using a~~ in a finite ~~q~~ number of steps by a computer. ~~Shall we~~ We shall call this

FINITE MATHEMATICS

<u>Infinite Numbers and decimal fractions with infinite places</u>

10. Finite mathematics, I believe, is logical and self-consistent, and everything we have in mathematical analysis that is relevant to solving practical problems is contained in it. So, we will leave it at that, and go to the question of how the concepts of "infinity" and the "infinitesimal" can be sought to be defined in a sufficiently precise manner for us to put (accepted the) the accepted domain of pure mathematics (particularly in functional analysis) in a form readily comprehensible from the above viewpoint.

1, 2, 3, 4, 5, 6, 7, 8
8, 7, 6, 5, 4, 3, 2, 1
8, 7, 6, 5, 4, 3, 2, 1
1, 2, 3, 4, 5, 6, 7, 8
1, 2, 3, 4, 5, 6, 7, 8
8, 7, 6, 5, 4, 3, 2, 1
8, 7, 6, 5, 4, 3, 2, 1
1, 2, 3, 4, 5, 6, 7, 8

0, 56, 56, 0, 0, 56, 56, 0
8, 48, 48, 8, 8, 48, 48, 8
16, 40, 40, 16, 16, 40, 40, 16
24, 32, 32, 24, 24, 32, 32, 24
32, 24, 24, 32, 32, 24, 24, 32
40, 16, 16, 40, 40, 16, 16, 40
48, 8, 8, 48, 48, 8, 8, 48
56, 0, 0, 56, 56, 0, 0, 56

1, 58, 59, 4, 5, 62, 63, 8
16, 55, 54, 13, 12, 51, 50, 9
24, 47, 46, 21, 20, 43, 42, 17
25, 34, 35, 28, 29, 38, 39, 32
33, 26, 27, 36, 37, 30, 31, 40
48, 23, 22, 45, 44, 19, 18, 41
56, 15, 14, 53, 52, 11, 10, 49
57, 2, 3, 60, 61, 6, 7, 64

Fig. 716 p. 391

6.4

1, 58, 3, 60, 61, 6, 63, 8

For Q & N

(1)

1, 2, 3, 4, 4, 3, 2, 1
8, 7, 6, 5, 5, 6, 7, 8
1, 2, 3, 4, 4, 3, 2, 1
8, 7, 6, 5, 5, 6, 7, 8
1, 2, 3, 4, 4, 3, 2, 1
8, 7, 6, 5, 5, 6, 7, 8
1, 2, 3, 4, 4, 3, 2, 1
8, 7, 6, 5, 5, 6, 7, 8

1, 58, 3, 60, 4, 59, 2, 57. 224
16, 55, 14, 53, 13, 54, 15, 56 276
17, 42, 19, 44, 20, 43, 18, 41
32, 39, 30, 37, 29, 38, 31, 40
25, 34, 27, 36, 28, 35, 26, 33
24, 47, 22, 45, 21, 46, 23, 48
9, 50, 11, 52, 12, 51, 10, 49
8, 63, 6, 61, 5, 62, 7, 64.

57, 2, 59, 4, 5, 62, 7, 64

1, 2, 3, 4, 5, 6, 7, 8
8, 7, 6, 5, 4, 3, 2, 8
1, 2, 3, 4, 5, 6, 7, 8
8, 7, 6, 5, 4, 3, 2, 8
1, 2, 3, 4, 5, 6, 7, 8
8, 7, 6, 5, 4, 3, 2, 8
1, 2, 3, 4, 5, 6, 7, 8
8, 7, 6, 5, 4, 3, 2, 8

1, 58, 3, 60, 5, 62, 7, 64.
16, 55, 14, 53, 12, 51, 10, 49
17, 42, 19, 44, 21, 46, 23, 48
32, 39, 30, 37, 28, 35, 26, 33
33, 26

1, 2, 3, 4, 8, 7, 6, 5
4, 3, 2, 1, 5, 6, 7, 8
1, 2, 3, 4, 8, 7, 6, 5
4, 3, 2, 1, 5, 6, 7, 8
1, 2, 3, 4, 8, 7, 6, 5
4, 3, 2, 1, 5, 6, 7, 8
1, 2, 3, 4, 8, 7, 6, 5
4, 2, 3, 1, 5, 6, 7, 8

~~1, 26, 3, 28~~ 8 + 11 + 21 + 26 not K-N
32 + 19 + 13 + 2

Different from what is in Fig. 716 p. 391

~~1, 3, 6, 8, 8, 6, 3, 1.~~

1, 3, 6, 8, 8, 6, 3, 1.
8, 6, 3, 1, 1, 3, 6, 8
1, 3, 6, 8, 8, 6, 3, 1
8, 6, 3, 1, 1, 3, 6, 8
1, 3, 6, 8, 8, 6, 3, 1
8, 6, 3, 1, 1, 3, 6, 8
1, 3, 6, 8, 8, 6, 3, 1
8, 6, 3, 1, 1, 3, 6, 8

1, 59, 6, 64, 8, 62, 3, 57.
24, 46, 19, 41, 17, 43, 22, 48
41, 19,

Must ~~still~~ not have complementary pairs

1, 6, 3, 8, 1, 6, 3, 8

121051
14641
161051
1771561
1771561

A $\bar{B}'$
B $\bar{A}'$
B' $\bar{A}$
A' $\bar{B}$
B' $\bar{A}$
A' $\bar{B}'$
A $\bar{B}'$
B $\bar{A}$

1, 7, 6, 4, 5, 3, 2, 8
x 8 2 3 5 4 6 7 1
1 8 2 3 5 4 6 7 1
5 3 2 8 x
+ 1 7 6 4 5 3 2 8 +
x 1 7 6 4 4 6 7 1
o 8 2 3 5 4 6 7 1
e 8 2 3 5 5 3 2 8 ✓
1 7 6 4

1, 6, 3, 8, 4, 7, 2, 5
4, 7, 2, 5, 1, 6, 3, 8

1	6	3	8	4	7	2	5

be listed, and that we cannot prove that q is not one of the a's. Hence, every q must have an ardhal representation.

[The proof can readily be extended to the decimal system, instead of the binary system; but this is trivial. The essence of the argument is there in the above].

Now, we shall try to prove Theorem 2; namely that the set of ardhals defined above ~~forms a continuous~~ are equivalent to the physical notion of a continuous variation of a quantity q.

Here, we come back to what we stated earlier ~~th~~ namely that the ~~idea~~ nature of ~~a~~ continuity can only be given in an intuitive way to begin with, which can then be made more and more precise, with rules as to what makes q a continuous variable, and when it is not so, by the technique of the block diagram in page 5.

So, the a priori definition of continuity which we shall use is by having [illegible] a distant vision of the object concerned, and then focussing the instrument used better and better, ending up with an electron microscopic view. This means that, initially, defining q to better than the first ~~decimal~~ ardhal place is not good. Thus

$$0{\cdot}0 < q < 0{\cdot}1 \qquad (12a)$$

Next, go to higher and higher ardhal places & write

$$0{\cdot}01 < q < 0{\cdot}11 \qquad (12b)$$

$$0{\cdot}011\ldots0 < q < 0{\cdot}011\ldots1 \qquad (12c)$$

1	6	3	8	4	7	2	5
4	7	2	5	1	6	3	8
5	2	7	4	8	3	6	1
8	3	6	1	5	2	7	4
5	2	7	4	8	3	6	1
8	3	6	1	5	2	7	4
1	6	3	8	4	7	2	5
4	7	2	5	1	6	3	8

(P)

$a_1', a_2', a_3', a_4' = d_1, d_2, d_3, d_4$

$a_5', a_6', a_7', a_8' = d_5, d_6, d_7, d_8$

$c_1', c_2', c_3', c_4' = b_1, b_2, b_3, b_4$

$b_1', b_2', b_3', b_4' = c_1, c_2, c_3, c_4$

$c_5', c_6', c_7', c_8' = b_5, b_6, b_7, b_8$

$b_5', b_6', b_7', b_8' = c_5, c_6, c_7, c_8$

$b_1, b_2, b_3, b_4 = a_5, a_6, a_7, a_8$

$b_5, b_6, b_7, b_8 = a_1, a_2, a_3, a_4$

$$\left.\begin{array}{l} a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8 \\ a_5, a_6, a_7, a_8, a_1, a_2, a_3, a_4 \\ a_5', a_6', a_7', a_8', a_1', a_2', a_3', a_4' \\ a_1', a_2', a_3', a_4', a_5', a_6', a_7', a_8' \end{array}\right\}$$

$a_8, a_7, a_6, a_5 = a$

Fig. 267, p. 169 of Andrews – $\underline{n}$ but not of the form on p. 92 of Bk. 20.?

First row of Q_1 is 64, 57, 4, 5 (a_1, a_2, a_3, a_4)

and first row of Q_4 is 40, 33, 28, 29 i.e. not complements of (a_1, a_2, a_3, a_4) as required in

$$\left.\begin{array}{l} 64-40 = 24 \\ 57-33 = 24 \\ 4-28 = -24 \\ 5-29 = -24 \end{array}\right\}$$

$a_5, a_6, a_7, a_8 = 56, 49, 12, 13$ ~~in Q_2~~ first row in Q_2

first row in Q_3 48, 41, 20, 21 – differences = 8, 8, –8, –8.

Similarly 3, 6, 63, 58 / 27, 30, 39, 34 } differences are –24, –24, 24, 24

| 11, 14, 55, 50 / 19, 22, 47, 42 / –8, –8, 8, 8.

|| 61, 60, 1, 8 / 37, 36, 25, 32 / 24, 24, –24, –24 }

53, 52, 9, 16 / 45, 44, 17, 24 / 8, 8, –8, –8

| 2, 7, 62, 59 / 26, 31, 38, 34 / –24, –24, 24, 24

10, 15, 54, 51 / 18, 23, 46, 43 / –8, –8, 8, 8 |

In the (P) ~~(R)~~ of above Fig. 267, we have (instead of) in the usual nasik scheme (i.e. p. 92, Bk. 20)

a_1, a_2, a_3, a_4, instead of a_1', a_2', a_3', a_4', etc. in corresp. rows of Q_1, Q_4, etc.

In (R) we have the above differences between rows of (Q_1, Q_4) & (Q_2, Q_3) instead of being complements

Figs for $\underline{a}$ & $\underline{n}$ squares on p. 92, Bk. 20 can be written shortly as

$\underline{a}$		$\underline{n}$	
A	E	A	E
B	F	B	F
C	G	C	G
D	H	D	H
H'	$\bar{D}$	E'	A'
$\bar{G}'$	$\bar{C}'$	F'	B'
$\bar{F}'$	$\bar{B}'$	G'	C'
$\bar{E}'$	$\bar{A}'$	H'	D'

in Fig. 267, p. 169 which is $\underline{n}$, the scheme [illegible]

(P)	(R)
A	A
B	B
$\bar{A}$	$\bar{A}$
$\bar{B}$	$\bar{B}$
A	A
B	B
$\bar{A}$	$\bar{A}$
$\bar{B}$	$\bar{B}$

8, 1, 4, 5

1, 8, 5, 4

$a_1 + d_6' + c_7' + b_8'$
$+ a_1' + d_6 + c_7 + b_8 = 4 \times 65 = \underline{\underline{260}}$

Physical Maths L I

multiplication and division of these, extended to the ardhal system for this purpose).

9. The third defines an irrational number, and we assert that all irrational numbers from 0 to 1 are given by ~~ardhal~~ non-terminating ardhal ~~dec~~ fractions. (XXI) ⇒

Proof: Suppose x lies between two (different terminating, or) non-terminating ~~different~~ ardhal fractions a_1 and a_2, which ~~may~~, or may not, be repeating. ~~Then~~ Then, they will agree upto an ardhal place n and disagree beyond. (~~Before comparing them~~ convert both a_1 and a_2 ~~into~~ ~~form A~~ (~~different~~) if either is repeating.) Thus, if $a_1 > a_2$, the $(n+1)$st place will be 1 for a_1 and 0 for a_2. Thereafter, look for the first opportunity of x there being 0 in a_2 and change it to 1, to get a new ardhal less than a_1 and greater than a_2. F!

(XXI) Theorem! First, we may suppose that all quantities between 0 and 1 can be represented by an ardhal fraction of types (i), (ii) or (iii). (So, we can generalise and say that all numbers between -2^m and $+2^m$ can be represented by a binary representation with m integer ~~dec~~ places and any number of ardhal places). We shall prove this for y between 0 and 1) —

"digit"

Thus, we have shown that, if $a_1 < x < a_2$, and (if we assume that) a_1 and a_2 are (neighbouring) ardhal fractions, ~~then x is~~ in our list, it leads to a contradiction that there is another ardhal fraction, say b, between a_1 and a_2. The conclusion we draw from this is that the a's cannot

8 8, 1, 4, 5, 8, 1, 4, 5

~~64, 57, 36, 13,~~

64, 57, 1, 4, 53, 56, 12, 13

~~1, 2, 3, 4, 1, 2, 3, 4~~

8, 3, 1, 1
6, 6, 3, 3.
7, 7, 2, 2 How to get (R_0)

1, 7, 6, 4, 1, 7, 6, 4	1, 4, 8, 5, 1, 4, 8, 5	1, 8, 4, 5, 1, 8, 4, 5
8, 2, 3, 5, 8, 2, 3, 5	3, 2, 6, 7, 3, 2, 6, 7	3, 6, 7, 2, 3, 6, 7, 2
4, 6, 7, 1, 4, 6, 7, 1	5, 8, 4, 1, 5, 8, 4, 1	5, 4, 8, 1, 5, 4, 8, 1
5, 3, 8, 2, 5, 3, 8, 2	7, 6, 2, 3, 7, 6, 2, 3	2, 7, 6, 3, 2, 7, 6, 3
1, 7, 6, 4, 1, 7, 6, 4	1, 4, 8, 5, 1, 4, 8, 5	1, 8, 4, 5, 1, 8, 4, 5
8, 2, 3, 5, 8, 2, 3, 5	3, 2, 6, 7, 3, 2, 6, 7	3, 6, 7, 2, 3, 6, 7, 2
4, 6, 7, 1, 4, 6, 7, 1	5, 8, 4, 1, 5, 8, 4, 1	5, 4, 8, 1, 5, 4, 8, 1
5, 3, 2, 8, 5, 3, 2, 8	7, 6, 2, 3, 7, 6, 2, 3	2, 7, 6, 3, 2, 7, 6, 3
not (i)	not (i)	(ii) (i)

1, 7, 3, 4, 4, 3, 7, 1.	0, 56, 56, 0, 56, 56	~~1, 63, 59, 4,~~ 1, 63, 3, 60, 4, 59, 7, 57
8, 2, 6, 5, 5, 6, 2, 8	48, 8, 8, 48, 48, 8, 8, 48	
1, 7, 3, 4, 4, 3, 7, 1	16, 40, 40, 16, 16, 40, 40, 16	
8, 2, 6, 5, 5, 6, 2, 8	24, 32, 32, 24, 24, 32, 32, 24	
1, 7, 3, 4, 4, 3, 7, 1	24, 32, 32, 24, 24, 32, 32, 24	
8, 2, 6, 5, 5, 6, 2, 8	16, 40, 40, 16, 16, 40, 40, 16	
1, 7, 3, 4, 4, 3, 7, 1	48, 8, 8, 48, 48, 8, 8, 48	
8, 2, 6, 5, 5, 6, 2, 8	0, 56, 56, 0, 0, 56, 56, 0	

~~Fig~~ Fig. 716, p. ~~109~~ 391, we get a soln

because we start with 1, 7, 6, 4 summing to 18

Suppose we start with 1, 3, 8, 6.

18 6 + 12, 3 + 15, 1 + 2 + 7 + 8, 4 + 14, 5 + 13, 1 + 4 + 6 + 7, 2 + 3 + 5 + 8, 6 + 12, 8 + 10, 7 + 11.

1, 3, 8, 6, 6, 8, 3, 1.	0, 56, 0, 56, 0, 56, 0, 56	1, 59, 8, 62, 6, 64, 3, 57.
8, 6, 1, 3, 3, 1, 6, 8	16, 40, 16, 40, 16, 40, 16, 40.	
1, 3, 8, 6, 6, 8, 3, 1.	56, 0, 56, 0, 56, 0, 56, 0.	
8, 6, 3, 1, 3, 1, 6, 8	40, 16, 40, 16, 40, 16, 40, 16	
1, 3, 6, 8, 6, 8, 3, 1.	40, 16, 40, 16, 40, 16, 40, 16	
8, 6, 3, 1, 3, 1, 6, 8	56, 0, 56, 0, 56, 0, 56, 0	
1, 3, 6, 8, 6, 8, 3, 1	16, 40, 16, 40, 16, 40, 16, 40	
8, 6, 3, 1. 3, 1, 6, 8	0, 56, 0, 56, 0, 56, 0, 56	5, 62, 3, 57, 3,

1, 7, 6, 4. 8 permutations
2, 5, 3, 8 "
3, 5, 8, 2

appear to be the only two cases.

1, 4, 6, 7
8, 5, 3, 2

2, 3, 5, 8, 8, 5, 3, 2.
7, 6, 4, 1, 1, 4, 6, 7.

Even these do not appear to give a soln squares inherently different from Fig. 716, p. ~~109~~ 391

Try

2, 3, 5, 8, 8, 5, 3, 2	8, 48, 8, 48, 8, 48, 8, 48	10, 51, ~~53~~, 56, 16, 53, 11, 50
7, 6, 4, 1, 1, 4, 6, 7	16, 40, 16, 40, 16, 40, 16, 40	23, 46, 20, 41, 17, 44, 22, 47
2, 3, 5, 8, 8, 5, 3, 2	32, 24, 32, 24, 32, 24, 32, 24	34, 27, 37, 32, 40, 29, 35, 26
7, 6, 4, 1, 1, 4, 6, 7	56, 0, 56, 0, 56, 0, 56, 0	63, 6, 60, 1, 57, 4, 62, 7
2, 3, 5, 8, 8, 5, 3, 2	56, 0, 56, 0, 56, 0, 56, 0	58, 3, 61, 8, 64, 5, 59, 2
7, 6, 4, 1, 1, 4, 6, 7	32, 24, 32, 24, 32, 24, 32, 24	39, 30, 36, 25, 33, 28, 38, 31
2, 3, 5, 8, 8, 5, 3, 2	16, 40, 16, 40, 16, 40, 16, 40	18, 43, 21, 48, 24, 45, 19, 42
7, 6, 4, 1, 1, 4, 6, 7	8, 48, 8, 48, 8, 48, 8, 48	15, 54, 12, 49, 9, 52, 14, 55

Not inherently different from Fig. 716, p. 391

So this appears unique

Physical Maths LI

~~Brief outline of further discussion~~

8. (a) ~~(a)~~ If the unit can be subdivided into halves again and again, we can measure any quantity q in the binary system [for convenience take $q < 1$], to as much accuracy as we want

$$q = 0 \cdot 1011101110100 1011 \cdots \qquad (10)$$

This is a practically applicable process to determine q — obviously, "whatever it may be, q can be determined.

b) This way of defining q shows that the "measure" of q is a continuous variable — by "continuous," we mean that there is no value that cannot be measured and defined this way. ~~(+)~~ 7

c) The subdivision of the unit may terminate, or may go on forever — Just as we use the word "decimal" fraction in the scale of ten, we may use the word "ardhal" fraction for the scale of two (3-TSf = half). Ardhal fractions are of 3 types:

(i) Terminating ~~at~~ after n ardhal places, all 0 beyond

(ii) Having Repeating finite sequence of 1's and 0's after n.

(iii) Non-repeating, non-terminating sequence

(Note I do not use the term 'infinite sequence', but non-terminating.)

The first is a rational number, being a countable multiple of $0 \cdot 000 \cdots 1$ ~~at~~ with 1 at the n^{th} ardhal place n.

The second is also rational, and ~~is the gene~~ can be obtained by generalizing the equality

$$\left.\begin{aligned} &0 \cdot 1000 \cdots\cdots\cdots \\ &= 0 \cdot 0111111 \cdots\cdots \end{aligned}\right\} \begin{matrix}\text{(Form A)} \\ \text{(Form B)}\end{matrix} \qquad (11)$$

[We have to use the rules of arithmetic and the usual techniques of dealing with fractions, including

1, 2, 3, 4, 5, 6, 7, 8

2, 3, 4, 5, 6, 7, 8, 1

3, 4, 5, 6, 7, 8, 1, 2

4, 5, 6, 7, 8, 1, 2, 3

8, 1, 2, 3, 4, 5, 6, 7

7, 8, 1, 2, 3, 4, 5, 6

6, 7, 8, 1, 2, 3, 4, 5

5, 6, 7, 8, 1, 2, 3, 4

~~1, 10, 19, 28, 37, 46, 55, 64~~

Rep

57, 2, 11, 20, 29, 38, 47, 56

50, 59, 4, 13, 22, 31, 40, 41

43, 52, 61, 6, 15, 24, 25, 34.

36, 45, 54, 63, 8, 9, 18, 27.

~~29, 30, 42, 56, 57~~

~~5, 14, 23, 32, 33, 42, 51, 60~~

~~5, 14, 23, 32, 33, 42, 51, 60~~

5, 14, 23, 32, 33, 42, 51, 60.

30, 39, 48, 49, 58, 3, 12, 21

~~23~~ 32,

~~Better~~

8th col + 1st row

7th col + 2nd row

6th col + 3rd row

5th col + 4th row

4th col + 5th row

~~4th col + 8th row~~

~~3rd col + 7th row~~

~~2nd col + 6th row~~

1st col + 5th row ✓

4th col + 6th row ✓

~~2nd col + 8th row~~

~~3rd col + 7th row~~

1st col + 8th row

2nd col + 7th row

3rd col + 6th row

4th col + 5th row

~~1, 10, 19, 28, 61, 54, 47, 40~~

1, 2, 3, 4, 5, 6, 7, 8

5, 6, 7, 8, 1, 2, 3, 4

1, 2, 3,

1, 2, 3, 4, 8, 7, 6, 5

8, 7, 6, 5, 1, 2, 3, 4

1, 2, 3, 4, 8, 7, 6, 5

8, 7, 6, 5, 1, 2, 3, 4

~~4, 3, 2, 1, 5, 6, 7, 8~~

~~5, 6, 7, 8, 4, 3, 2, 1~~

~~4, 3, 2, 1, 5, 6, 7, 8~~

5, 6, 7, 8, 4, 3, 2, 1.

1, 58, 3, 60, ~~32~~, ~~39~~, 50, 37.

16, 55, ~~14~~, 53, ~~17~~, 42, 19, 44.

17, 42, 19,

1, 7, 6, 4, 1, 7, 6, 4

8, 2, 3, 5, 8, 2, 3, 5

1, 7, 6, 4, 1, 7, 6, 4

8, 2, 3, 5, 8, 2, 3, 5

8, 2, 3, 5, 8, 2, 3, 5

1, 7, 6, 4, 1, 7, 6, 4

8, 2, 3, 5, 8, 2, 3, 5

1, 7, 6, 4, 1, 7, 6, 4.

1, 63	6, 60	57, 7	62, 4
56, 10	51, 13	16, 50	11, 53
41, 23	46, 20	17, 47	22, 44
32, 34	27, 37	40, 26	35, 29
8, 58	3, 61	64, 2	59, 5
49, 15	54, 12	9, 55	14, 52
48, 18	43, 21	24, 42	19, 45
25, 39	30, 36	33, 31	38, 28

a new result.

all 16 subsquares of 2 × 2 add up to 130

Hence algebraic

25 + 43 + 9 + 59

32 + 46 + 16 + 62 = 292 X not k-n

1, 7, 6, 4, 4, 6, 7, 1.

8, 2, 3, 5, 5, 3, 2, 8

1, 7, 6, 4, 4, 6, 7, 1

8, 2, 3, 5, 5, 3, 2, 8

8, 2, 3, 5, 5, 3, 2, 8

1, 7, 6, 4, 4, 6, 7, 1

8, 2, 3, 5, 5, 3, 2, 8

1, 7, 6, 4, 4, 6, 7, 1

~~1, 5, 5, 6, 6, 6, 6, 5~~ 1

1, 3, 6, 8, 1, 3, 6, 8

8, 6, 3, 1, 8, 6, 3, 1

1, 3, 6, 8, 1, 3, 6, 8

8, 6, 3, 1, 8, 6, 3, 1

8, 6, 3, 1, 8, 6, 3, 1.

1, 3, 6, 8, 1, 3, 6, 8

8, 6, 3, 1, 8, 6, 3, 1

1, 3, 6, 8, 1, 3, 6, 8

~~Mar 64.~~

X rep

1, 2, 3, 4, 8, 7, 6, 5

0, 8, 16, 24, 56, 48, 40, 32

1, 4, 2, 3

1, 3, 5, 7.

Study 734, p. 397 q

Answer

(P) is yet to form A, A', A, ... } in cols with A = (1, 4, 2, 3).

A', A,

A, A', A, A' } in rows with A = (1, 5, 3, 7)

Operation A = (1, 2, 3, 4) both in (P) & (R)

(R) " fails

For Takasi (R), A = (1, 7, 4, 6).

1, 8, 1, 8, 1, 8, 1, 8

2, 7, 2, 7, 2, 7, 2, 7

3, 6, 3, 6, 3, 6, 3, 6

4, 5, 4, 5, 4, 5, 4, 5

8, 1, 8, 1, 8, 1, 8, 1

7, 2, 7, 2, 7, 2, 7, 2

6, 3, 6, 3, 6, 3, 6, 3

5, 4, 5, 4, 5, 4, 5, 4

~~0, 8, 16, 24, 56, 48, 40, 32~~

~~56, 48, 40, 32, 0, 8, 16, 24~~

~~0, 8, 16, 24, 56, 48, 40, 32~~

56, 48, 40, 32, 0, 8, 16, 24

0, 48, 24, 40, 56, 8, 32, 16.

56, 8, 32, 16, 0, 48, 24, 40

0, 48, 24, 40, 56, 8, 32, 16

56, 8, 32, 16, 0, 48, 24, 40

0, 48, 24, 40, 56, 8, 32, 16

56, 8, 32, 16, 0, 48, 24, 40

0, 48, 24, 40, 56, 8, 32, 16

56, 8, 32, 16, 0, 48, 24, 40

1	56	25	48	57	16	33	24
58	55	34	23	2	55	26	47
3	54	27	46	59	14	35	22
60	13	36	21	4	53	28	45
8	49	32	41	64	9	40	17
63	10	39	18	7	50	31	42
6	51	30	43	62	11	38	19
61	12	37	20	5	52	29	44

pre Study 734 p. 397 also result, 4 fold, k-n new one ✓

(2, 1) → 61 + 30 + 7 + 40 + 60 + 27 + 2 + 33 = 260 ✓

(2, −1) → 61 + 25 + 2 + 35 + 60 + 32 + 7 + 38 = 260 ✓

(1, 2) → 61 + 10 + 36 + 23 + 5 + 50 + 28 + 47 = 260 ✓

(1, −2) → 61 + 15 + 36 + 18 + 5 + 55 + 28 + 42 = 260 ✓

The n's appear any but the (a Δ n) & (n+a − n Δ n) appear significant we have the values of q_1, q_2, q_3, in terms of u, as

$$\left.\begin{aligned} q_1 &= a_1 b_2 b_3 u = n_1 u \\ q_2 &= a_2 b_1 b_3 u = n_2 u \\ q_3 &= a_3 b_1 b_2 u = n_3 u \end{aligned}\right\} \quad (9)$$

where n_1, n_2, n_3 are finite integers. If the unit u is "infinitesmally small", that is, b_1, b_2, b_3 are infinitely large in (8), then n_1, n_2, n_3 are also infinitely large, and we must have a precisely defined way of multiplying an infinitely small quantity by an infinitely large integer to go anywhere forward from here.

So, we need logical, rigorous definitions of infinity and methods of dealing with ratios of infinite numbers, so that we do not commit errors in manipulating them. (Of course, there are rules of this type in accepted rigorous pure mathematics, but they ~~and~~ have one defect, as we see it, in that "the set of all rational numbers" can be thought of, without including in it the ideas of continuity and of the infinitesmally small unit.). By saying that we limit ourselves to integers and their manipulations in finite arithmetic on one side and that we discuss what are the properties of continuous real variables and their algebra on the other side, we bring out the ~~real~~ precise nature and notion of the latter to represent any "quantity" in physics. We will find that continuity is an ~~intuitive~~ intuitive primitive notion in physics, and all that rigorous mathematics can do is to clothe it

1,7,3,4,5,6,2,8
1,2,6,4,5,3,7,8
8,2,6,5,4,3,7,1
8,7,3,5,4,6,2,1
8,7,3,5,4,6,2,1
8,2,6,5,4,3,7,1
1,2,6,4,5,3,7,8
1,7,3,4,5,6,2,8

1,63,59,4,5,62,58,8
17,42,46,20,21,43,47,24
16,50,54,13,12,51,55,9
32,39,35,29,28,38,34,25
40,31,27,37,36,30,26,33
56,10,14,53,52,11,15,49
41,18,22,44,45,19,23,48
57,7,3,60,61,6,2,64

(P) of Fig. 107 + (R) of Fig. 105 → associative square

Find an alternative to Fig. 262, p. 165 of Andrews but having the same properties.

~~1,4,3~~, 1,6,5,2.

1,6,5,2,8,3,4,7
8,3,4,7,1,6,5,2
1,6,5,2,8,3,4,7
8,3,4,7,1,6,5,2
1,6,5,2,8,3,4,7
8,3,4,7,1,6,5,2
1,6,5,2,8,3,4,7
8,3,4,7,1,6,5,2

0,56,0,56,0,56,0,56
40,16,40,16,40,16,40,16
32,24,32,24,32,24,32,24
8,48,8,48,8,48,8,48
56,0,56,0,56,0,56,0
16,40,16,40,16,40,16,40
24,32,24,32,24,32,24,32
48,8,48,8,48,8,48,8

1,62,5,58,8,59,4,63
48,19,44,23,41,22,45,18
33,30,37,26,40,27,36,31
16,51,12,55,9,54,13,50
57,6,61,2,64,3,60,7
24,43,20,47,17,46,21,42
25,38,29,34,32,35,28,39
56,11,52,15,49,14,53,10

4-ply.
56 + 29 + 17 + 60 + 16 + 37 + 41 + 4 = 260 ✓
56 + 5 + 41 + 36 + 16 + 61 + 17 + 28 = 260 ✓
56 + 43 + 12 + 23 + 49 + 46 + 13 + 18 = 260 ✓
56 + 19 + 12 + 47 + 49 + 22 + 13 + 42 = 260 ✓
also Knight nasick

56 + 29 + 17 + 60 + 16 + 37 + 41 + 4
11 + 34 +

For (2,1):
56 + 29 + 17 + 60 + 16 + 37 + 41 + 4 = 260
11 + 34 + 46 + 7 + 51 + 26 + 22 + 63 = 260
52 + 32 + 21 + 57 + 12 + 40 + 45 + 1 = 260
15 + 35 + 42 + 6 + 55 + 27 + 18 + 62 = 260
(18) 49 + 28 + 24 + 61 + 9 + 36 + 48 + 5 = 260 ←
14 + 39 + 43 + 2 + 54 + 31 + 19 + 58 = 260
53 + 25 + 20 + 64 + 13 + 33 + 44 + 8 = 260
10 + 38 + 47 + 3 + 50 + 30 + 23 + 59 = 260

For (2,−1).
56 + 5 + 41 + 36 + 16 + 61 + 17 + 28 = 260.
11 + 58 + 22 + 31 + 51 + 2 + 46 + 39 = 260
52 + 8 + 45 + 33 + 12 + 64 + 21 + 25 = 260
15 + 59 + 18 + 30 + 55 + 3 + 42 + 38 = 260
49 + 4 + 48 + 37 + 9 + 60 + 24 + 29 = 260
14 + 63 + 19 + 26 + 54 + 7 + 43 + 34 = 260
53 + 1 + 44 + 40 + 13 + 57 + 20 + 32 = 260
10 + 62 + 23 + 27 + 50 + 6 + 47 + 35 = 260

10 + 20 + 54 + 48 + 15 + 21 + 57 + 41 = ~~258~~ 260 //
10 + 39 + 42 + 7 + 50 + 31 + 18 + 63 = 260 //

33,6,29,58,40,3,28,63
12,47,49,22,13,42,50,19

39 + 61 + 27 + 1 + 34 + 60 + 30 + 8 = 260 ✓
39 + 43 + 2 + 52 + 31 + 19 + 58 + 14 = ~~246~~ 260 ✓

8,5,1,4,8,5,1,4
3,2,6,7,3,2,6,7
4,8,5,1,4,8,5,1
7,3,2,6,7,3,2,6
1,4,8,5,1,4,8,5
6,7,3,2,6,7,3,2
5,1,4,8,5,1,4,8
2,6,7,3,2,6,7,3

Putting this r ↔ c
(P)

7,4,3,8,2,5,6,1
2,5,6,1,7,4,3,8
7,4,3,8,2,5,6,1
2,5,6,1,7,4,3,8
7,4,3,8,2,5,6,1
2,5,6,1,7,4,3,8
7,4,3,8,2,5,6,1
2,5,6,1,7,4,3,8
(R)

This gives another way of getting a nasick

(19)

8,3,4,7,1,6,5,2.
5,2,8,3,4,7,1,6
1,6,5,2,8,3,4,7
4,7,1,6,5,2,8,3.
✓ 8,3,4,7,1,6,5,2
✗ 5,2,8,3,4,7,1,6
1,6,5,2,8,3,4,7
4,7,1,6,5,2,8,3.
(P′)

(P′) is
A, A′
B, B′
A′, A
B′, B
A, A′
B, B′
A′, A
B′, B

with A & B having no complementary pairs

a_1, a_2, a_3, a_4
a_3', a_4', a_1, a_2

(R) is A_1, A_1'
A_1', A_1
A_1, A_1'
A_1', A_1
A_1, A_1'
A_1', A_1
A_1, A_1'
A_1', A_1

with $A_1 = \bar{A}$

64,35,4,31,57,38,5,26
21,10,48,51,20,15,41,54
25,62,37,2,32,59,36,7.
52,23,9,46,53,18,16,43
8,27,60,39,1,30,61,34
45,50,24,5,44,55,17,14

they had in having an infinite subdivision of matter (~~of~~ or of anything) was that there could be no difference in the number of units, which could be readily conceived of, between the masses of a pin and a mountain, because both would be infinitely large. (I am using the word 'infinite' quite freely without defining it, but the idea is quite clear). So, we must have a precise, logical, understanding of infinity — the infinitely large and the infinitely small. The latter is intimately connected with our notions of "continuity". & Note that we do not need to consider functions and their behaviour at all to discuss continuity. It is necessary even in the very notion of a ~~q~~ quantity in physics, or a variable in mathematics — what do we mean when we say that x is a real variable, as distinct from x being an integer. There are only these two possibilities, as we shall show below. There is no such thing between them, as "the set of all rational numbers". In fact, this set cannot be defined at all, as far as physics is concerned, except in terms of integers.

We may illustrate this as follows. Suppose we have three quantities q_1, q_2, q_3 in terms of some unit $[V]$ such that

$$q_1 = \frac{a_1}{b_1}V, \quad q_2 = \frac{a_2}{b_2}V \quad q_3 = \frac{a_3}{b_3}V, \quad a_i, b_i \text{ finite integers} \qquad (7)$$

Then, multiplying by $b_1 b_2 b_3$ ~~and~~ (assume $(b_1, b_2, b_3) = 1$ for convenience), and calling the new unit

$$u = V / b_1 b_2 b_3 \qquad (8)$$

$56+43+12+23+49+46+13+18=260$
$11+20+55+41+14+21+50+48=260$
$52+47+9+22+53+42+16+19=260$
$15+17+54+45+10+24+51+44=260$
$49+46+13+18+56+43+12+23=260$
$14+21+50+48+11+20+55+41=260$
$53+42+16+19+52+47+9+22=260$
$10+24+51+44+15+17+54+45=260$

(1,-2). $56+19+12+47+49+22+13+42=260$

Just like above
1st row & 5th row same
2nd & 6th
3rd & 7th
4th & 8th

(1,2) col. elements
$56+43+12+23+49+46+13+18=260$
$25+6+37+58+32+3+36+63=260$
$24+51+44+15+17+54+45+10=260$
$57+30+5+34+64+27+4+39=260$
$16+19+52+47+9+22+53+42=260$
$33+62+29+2+40+59+28+7=260$
$48+11+20+55+41+14+21+50=260$
$1+38+61+26+8+35+60+31=260$
(7) (20)

(1,-2). $56+19+12+47+49+22+13+42=260$.
$25+62+37+2+32+59+36+7=260$
$24+11+44+55+17+14+45+50=260$
$57+38+5+26+64+35+4+31=260$
$16+43+52+23+9+46+53+18=260$
$33+6+29+58+40+3+28+63=260$
$48+51+20+15+41+54+21+10=260$
$1+30+61+34+8+27+60+39=260$
(21)

8,3,4,7	2,5,6,1	56,32,0,24	24,0,32,56	64,35,4,31	26,5,38,57
5,2,8,3	6,1,7,4	16,8,40,48	48,40,8,16	21,10,48,51	54,41,15,20
1,6,5,2	7,4,3,8	24,56,32,0	0,32,56,24	25,62,37,2	7,36,59,32
4,7,1,6	3,8,2,5	48,16,8,40	40,8,16,48	52,23,9,46	43,16,18,53
4,7,1,6	3,8,2,5	8,40,48,16	16,48,40,8	12,47,49,22	19,56,42,13
1,6,5,2	7,4,3,8	32,0,24,56	56,24,0,32	33,6,29,58	63,28,3,40
5,2,8,3	6,1,7,4	40,48,16,8	8,16,48,40	45,50,24,11	44,17,55,44
8,3,4,7	2,5,6,1	0,24,56,32	32,56,24,0	8,27,60,39	34,61,30,1.

associated allright.

64,35,4,31	57,38,5,26.
21,10,48,51	20,15,41,54
25,62,37,2	32,59,36,7
52,23,9,46	53,18,16,43
8,27,60,39	1,30,61,34
45,50,24,11	44,55,17,14
33,6,29,58	40,3,28,63
12,47,49,22	13,42,56,19

A	A'	A	, $\bar{A}'$
A'	A	A'	, $\bar{A}$
A	A'	A	, $\bar{A}$
A'	A	A'	, $\bar{A}$
A	A'	A'	, $\bar{A}$
A'	A	A	, $\bar{A}'$
A	A'	A'	, $\bar{A}$
A'	A	A	, $\bar{A}'$

a_1, a_2, a_3, a_4
a_3', a_4', a_1, a_2
a_3, a_2, a_1', a_2'.

$8+24+63+42+52+37+54+38=318$ X

13, 42, 56, 19
40, 3, 28, 63
44, 55, 17, 14
1, 30, 61, 4

8

A, A'
B, B'
A', A
B', B
A, A'
B, B'
A', A
B', B

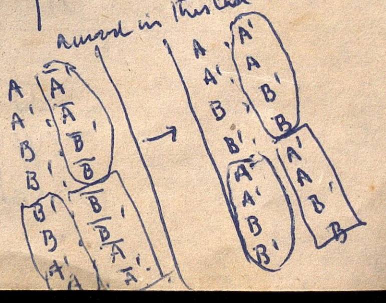
8,3,4,7	1,6,5,2
5,2,8,3	4,7,1,6
1,6,5,2	8,3,4,7
4,7,1,6	5,2,8,3
8,3,4,7	~~0,24,56,32~~ 1,6,5,2
5,2,8,3	~~40,48,16,8~~ 4,7,1,6
1,6,5,2	8,3,4,7
4,7,1,6	5,2,8,3

56,32,0,24	56,32,0,24
16,8,40,48	16,8,40,48
24,56,32,0	24,56,32,0
48,16,8,40	48,16,8,40
0,24,56,32	40,24,56,32
40,48,16,8	40,48,16,8
32,0,24,56	32,0,24,56
8,40,48,16	8,40,48,16

8,3,4,7	56,32,0,24,
5,2,8,3	16,8,40,48
1,6,5,2	24,56,32,0
4,7,1,6	48,16,8,40

Planck's rule for converting associated into nasiks (Andrews p 266)

Amend in this case to change



kg, gram, or mg is immaterial. If now, the unit can be made as small as we ~~please~~ like, every object concerned will have a "very large number" of units, and the process of comparison of the quantities concerned becomes more and more difficult. ~~Ultimately, if the unit is so small~~ The question is not one of practicality, but that of concept. In principle, can the unit be made so small that ~~any tr~~ [illegible] the quantity concerned for any object can be expressed mathematically. Intuitively we feel that this ~~is~~ is possible — it requires for this purpose the process of "infinite division" (We have not yet defined ~~any~~ really the terms "infinite", or "division"). However, let us say that division is understood for rational numbers, which are ratios of finite integers p/q. The steps needed for these are fairly simple, and can be rigorously stated, & we shall not discuss them.

6. On the other hand, the concept of something being "infinite," even in the domain of integers, requires careful consideration, or definitions. It is intimately connected with the precise knowledge of the "infinitesmal" also. One cannot think of one without thinking of the other. ~~Any~~

अणोरणीयान् महतो महीयान्

The idea of an atom, or an ~~infinitesmal unit~~ quantum which must be finite, in order that everything we see or use can be expressed as a finite number of multiples of this unit, has come even in the B.C's. (Democritus in Greece, and Kanada in India). The real difficulty

To find an O & E of p. 49 (tuple) using (A, B, A', B' etc of rounds)

$38+29+40+31+35+28+33+26 = 260$ ✓
$38+37+40+39+35+36+33+34 = 29\,2$ X

(8)

~~1,5,6~~

(A) 1, 7, 4, 6
~~8, 2, 5, 3~~
~~3, 5, 2~~
~~6, 4, 7, 1~~
(B) 4, 6, 1, 7.

1, 7, 4, 6, 8, 2, 5, 3
6, 4, 7, 1, 3, 5, 2, 8
8, 2, 5, 3, 1, 7, 4, 6
3, 5, 2, 8, 6, 4, 7, 1
1, 7, 4, 6, 8, 2, 5, 3
6, 4, 7, 1, 3, 5, 2, 8
8, 2, 5, 3, 1, 7, 4, 6
3, 5, 2, 8, 6, 4, 7, 1

0, 40, 56, 16, 0, 40, 56, 16
48, 24, 8, 32, 48, 24, 8, 32
24, 48, 32, 8, 24, 48, 32, 8
40, 0, 16, 56, 40, 0, 16, 56.
56, 16, 0, 40, 56, 16, 0, 40
8, 32, 48, 24, 8, 32, 48, 24
32, 8, 24, 48, 32, 8, 24, 48
16, 56, 40, 0, 16, 56, 40, 0

1, 47, 60, 22, 8, 42, 61, 19
54, 28, 15, 33, 51, 29, 10, 40
32, 50, 37, 11, 25, 55, 36, 14
43, 5, 18, 64, 46, 4, 23, 57
57, 23, 4, 46

repetition X

Does not work

1, 2, 3, 4, 1, 7, 3, 5

$32+17+56+57$
$+40+41+16+1 = 260$

$20+53+60+37$
$+44+13+4+29 = 260$

$54+59+38+43$
$14+3+30+19 = 260$

~~1, 7, 6, 4~~
~~6, 4, 8, 2~~
~~6, 4, 8, 2~~
~~1, 7, 6, 4~~
~~6, 4, 8, 2~~
~~6, 4, 8, 2~~

1, 7, 6, 4, 8, 2, 3, 5
8, 2, 3, 5, 1, 7, 6, 4
6, 4, 8, 2, 3, 5, 1, 7
3, 5, 1, 7, 6, 4, 8, 2
1, 7, 6, 4, 8, 2, 3, 5
8, 2, 3, 5, 1, 7, 6, 4
6, 4, 8, 2, 3, 5, 1, 7
3, 5, 1, 7, 6, 4, 8, 2

0, 56, 40, 16, 0, 56, 40, 16
48, 8, 24, 32, 48, 8, 24, 32
40, 16, 56, 0, 40, 16, 56, 0.
24, 32, 8, 48, 24, 32, 8, 48
56, 0, 16, 40, 56, 0, 16, 40
8, 48, 32, 24, 8, 48, 32, 24
16, 40, 0, 56, 16, 40, 0, 56
32, 24, 48, 8, 32, 24, 48, 8

1, 63, 46, 20, 8, 58, 43, 21.
56, 10, 27, 37, 49, 15, 30, 36
46, 20, 64, 2, 43, 21,

Repetition X
Does not work

A
A'
B
B'

with B = (a_3, a_4, a_1', a_2')
does not work.

$50+14+53+16$
$+55+11+52+9 = 260$ ✓

$20+28+4+12+44+36+60+52 = 256$

$38+43+14+3+30+19+54+59 = 260$ ✓
$38+62+54+22+30+6+14+46 = 272$ X

A (a_1, a_2, a_3, a_4), B = (a_3', a_4', a_1', a_2')

A (1, 7, 6, 4)
B (3, 5, 1, 7)

A
A'
B
B'

Ex. 3

A (a_1, a_2, a_3, a_4)
B (a_3', a_4', a_1', a_2')

1, 7, 6, 4, 8, 2, 3, 5
3, 5, 1, 7, 6, 4, 8, 2
8, 2, 3, 5, 1, 7, 6, 4
6, 4, 8, 2, 3, 5, 1, 7
1, 7, 6, 4, 8, 2, 3, 5
3, 5, 1, 7, 6, 4, 8, 2
8, 2, 3, 5, 1, 7, 6, 4
6, 4, 8, 2, 3, 5, 1, 7.

0, 16, 56, 40, 0, 16, 56, 40
48, 32, 8, 24, 48, 32, 8, 24
40, 0, 16, 56, 40, 0, 16, 56
24, 48, 32, 8, 24, 48, 32, 8
56, 40, 0, 16, 56, 40, 0, 16
8, 24, 48, 32, 8, 24, 48, 32
16, 56, 40, 0, 16, 56, 40, 0
32, 8, 24, 48, 32, 8, 24, 48

1, 23, 62, 44, 8, 18, 59, 45
51, 37, 39, 31, 54, 36, 16, 26
48, 2, 19, 61, 41, 7, 22, 60
30, 52, 40, 10, 27, 53, 33, 15
57, 47, 6, 20, 64, 42, 3, 21.
11, 29, 49, 39, 14, 28, 56, 34
24, 58, 43, 5, 17, 63, 46, 4
38, 12, 32, 50, 35, 13, 25, 55

n

works for (A, B, A', B') ✓

A . A' . A'
A' . A . A
B . B' . B'
B' . B . B
A . A' . A'
B . B' . A
A' . B' . A .
A . B . B

$38+43+14+3$
$30+19+54+59 = 260$

$12+5+29+21$
$52+61+36+45 = 260$

Ex. 2 with rounds take A = (a_1, a_2, a_3, a_4), B = (a_1', a_2', a_3', a_4') & (A, A', B, B')

A (1, 2, 3, 4)
B (1, 7, 3, 5)

Ex. 2

A (a_1, a_2, a_3, a_4)
B (a_1', a_2', a_3', a_4')

A 1, 2, 3, 4, 8, 7, 6, 5
A' 8, 7, 6, 5, 1, 2, 3, 4
B 1, 7, 3, 5, 8, 2, 6, 4
B' 8, 2, 6, 4, 1, 7, 3, 5
1, 2, 3, 4, 8, 7, 6, 5
8, 7, 6, 5, 1, 2, 3, 4
1, 7, 3, 5, 8, 2, 6, 4
8, 2, 6, 4, 1, 7, 3, 5

0, 56, 0, 56, 0, 56, 0, 56
8, 48, 48, 8, 8, 48, 48, 8
16, 40, 16, 40, 16, 40, 16, 40
24, 32, 32, 24, 24, 32, 32, 24
56, 0, 56, 0, 56, 0, 56, 0
48, 8, 8, 48, 48, 8, 8, 48
40, 16, 40, 16, 40, 16, 40, 16
32, 24, 24, 32, 32, 24, 24, 32

1, 58	3, 60	8, 63	6, 61
16, 55	54, 13	9, 50	51, 12
17, 47	19, 45	24, 42	22, 44
32, 34	38, 28	25, 39	35, 29
57, 2	59, 4	64, 7	62, 5
56, 15	14, 53	49, 10	11, 52
41, 23	43, 21	48, 18	46, 20
40, 26	30, 36	33, 31	27, 37

n ✓

$33+46+56+59$
$+24+51+1+30 = 300$ X

not k-n

$40+43+49+62$
$+32+19+9+6 = 260$ not 4-ph

$33+10+35+12+$
$+40+15+38+13 = 196$ X
$+33+$

$40+15+38+13$

$26+14+28+8$
$31+11+29+16 = 260$

$33+46+56+59$
$+25+22+16+3 = 260$

Ex. 1

$a_1 a_2 a_3 a_4$
$a_2 a_1 a_4 a_3$
$a_3 a_4 a_1 a_2$
$a_4 a_3 a_2 a_1$

does not work

1, 4, 3, 2, 8, 5, 6, 7
3, 2, 8, 5, 6, 7, 1, 4
6, 7, 1, 4, 3, 2, 8, 5
8, 5, 6, 7, 1, 4, 3, 2
1, 4, 3, 2, 8, 5, 6, 7
3, 2, 8, 5, 6, 7, 1, 4
6, 7, 1, 4, 3, 2, 8, 5
8, 5, 6, 7, 1, 4, 3, 2

0, 16, 40, 56, 0, 16, 40, 56
24, 8, 48, 32, 24, 8, 48, 32
16, 56, 0, 40, 16, 56, 0, 40
8, 32, 24, 48, 8, 32, 24, 48
56, 40, 16, 0, 56, 40, 16, 0
32, 48, 8, 24, 32, 48, 8, 24
40, 0, 56, 16, 40, 0, 56, 16
48, 24, 32, 8, 48, 24, 32, 8

1, 20, 43, 58, 8, 21, 46, 63
27, 10, 56, 37, 30, 15, 49, 36
22, 63,

does not work

So cancel the last alternative under A, B, C, D for mark square

$50+63+34+47+10+7+26+23 = 260$ ✓

(P. T. O) for Ex. 1

$64+11+41+30$
$+8+51+17+38 = 260$ ✓

$38+62+54+22$
$+30+6+14+46 = 272$ X

$38+62+54+22$
$+30+6+14+46 = 272$ X

$40+3+9+22$
$+32+59+49+46 = 260$ ✓

$2+31+18+55$
$+58+39+42+15 = 260$ ✓

$12+49+10+54+13+56+55+51 = 260$ ✓

have ~~an~~ a "quantum", with all quantities of this type having an integral number of quanta. [Note that no multiplication is involved in this, but only the most elementary concept of "counting"].

Thus, if the quantum exists for the physical entity we are considering, then, as far as that is concerned, integer arithmetic will do. [I am jumping ahead and assuming that we have arrived at the laws of arithmetic — addition, subtraction, multiplication and division. I shall not consider the structure of the rules of arithmetic and find out which are fundamental or basic, and which can be derived from them. For the present, I shall not take into account the extension of division to define rational numbers; but shall use it where necessary without any special comment, unless one is called for.]

Therefore one naturally asks the question — is "everything" a multiple of a unit, or can they be different? In the former case, life is easy, and, if it is not so, some apparently logical inconsistencies arise. For example, if there is no unit of ~~mass~~ or weight, how would one ever test that two objects have the same mass? — The same with the length of two lines, although, in this case, the two lines may be superposed and compared (also with two masses by a balance). However, no science or physics is possible unless we can have a method of measuring things, and this requires always a unit — whether it is a

Ex. 4

a_1, a_2, a_3, a_4

A = (1,2,6,5)

B = (8,2,3,5)

C = (1,7,6,4)

D = (8,7,3,4)

1, 2, 6, 5, 8, 7, 3, 4
8, 2, 3, 5, 1, 7, 6, 4
1, 7, 6, 4, 8, 2, 3, 5
8, 7, 3, 4, 1, 2, 6, 5
1, 2, 6, 5, 8, 7, 3, 4
8, 2, 3, 5, 1, 7, 6, 4
1, 7, 6, 4, 8, 2, 3, 5
8, 7, 3, 4, 1, 2, 6, 5

0, 56, 0, 56, 0, 56, 0, 56
8, 8, 48, 48, 8, 8, 48, 48
40, 16, 40, 16, 40, 16, 40, 16
32, 32, 24, 24, 32, 32, 24, 24
56, 0, 56, 0, 56, 0, 56, 0
48, 48, 8, 8, 48, 48, 8, 8
16, 40, 16, 40, 16, 40, 16, 40
24, 24, 32, 32, 24, 24, 32, 32

1, 58, 6, 61, 8, 63, 3, 60
16, 10, 51, 53, 9, 15, 54, 52
41, 23, 46, 20, 48, 18, 43, 21
40, 39, 27, 28, 33, 34, 30, 29
57, 2, 62, 5, 64, 7, 59, 4
56, 50, 11, 13, 49, 55, 14, 12
17, 47, 22, 44, 24, 42, 19, 45
32, 31, 35, 36, 25, 26, 38, 37

2, 4, 5, 7 | 2, 61, 60, 7
18, 20, 21, 23 | 47, 20, 21, 42
42, 44, 45, 47 | 23, 44, 45, 18
58, 60, 61, 63 | 38, 5, 4, 63

32 + 22 + 49 + 30 = X
41 + 51 + 8 + 38 = 1 (9)
n (2) 32 + 6 + 9 + 43 + 40 + 62 + 49 + 19 = 260
~~wrong~~
4, 4, 32 + 50 + 27 + 53
25 + 55 + 30 + 52 = 4 X
32 + 10 + 27 + 13 + 25
15 + 30 + 45 + 1 = 8 X

~~2, 21, 23~~
2, 61, 23, 44
47, 20, 58, 5
60, 7, 45, 18
21, 42, 4, 63

Q1

Ex. 5 (P) from (1,3,5,7) & R from (8,6,4,2) & scheme (A, A', A, A')

1, 3, 5, 7, 8, 6, 4, 2
8, 6, 4, 2, 1, 3, 5, 7
1, 3, 5, 7, 8, 6, 4, 2
8, 6, 4, 2, 1, 3, 5, 7
1, 3, 5, 7, 8, 6, 4, 2
8, 6, 4, 2, 1, 3, 5, 7
1, 3, 5, 7, 8, 6, 4, 2
8, 6, 4, 2, 1, 3, 5, 7

56, 0, 56, 0, 56, 0, 56, 0
40, 16, 40, 16, 40, 16, 40, 16
24, 32, 24, 32, 24, 32, 24, 32
8, 48, 8, 48, 8, 48, 8, 48
0, 56, 0, 56, 0, 56, 8, 56
16, 40, 16, 40, 16, 40, 16, 40
32, 24, 32, 24, 32, 24, 32, 24
48, 8, 48, 8, 48, 8, 48, 8

128 132

57, 3, 61, 7 | 64, 6, 60, 2
48, 22, 44, 18 | 41, 19, 45, 23
25, 35, 29, 39 | 32, 38, 28, 34
16, 54, 12, 50 | 9, 51, 13, 55
7, 59, 5, 63 | 8, 62, 4, 58
24, 46, 20, 42 | 17, 43, 21, 47
33, 27, 37, 31 | 40, 30, 36, 26
56, 14, 52, 10 | 49, 11, 53, 15

n ✓

56 + 37 + 17 + 4 + 16 + 29 + 41 + 60 = 260
56 + 61 + 41 + 28 + 16 + 5 + 17 + 36 = 260
56 + 26 + 12 + 18 + 49 + 43 + 13 + 23 = 260
4-ply. 56 + 22 + 12 + 42 + 49 + 19 + 13 + 47 = 260

(α)

also Knight-neath also 0, 0, 0, 0, e, e, e, e
e, e, e, e, 0, 0, 0, 0

wasted energy in trying to make this magic by ~~accident~~

find pattern

60, 2, 61, 7 | 64, 6, 57, 3
45, 23, 44, 18 | 41, 19, 48, 22
28, 34, 29, 39 | 32, 38, 25, 35
~~13, 55, 12, 50~~ | ~~16~~
13, 55, 12, 50 | 9, 51, 16, 54

146
114

32
16

(β)

60, 2, 61, 7 | 64, 6, 57, 3
45, 23, 44, 18 | 41, 19, 48, 22
28, 34, 29, 39 | 32, 38, 25, 35
13, 55, 12, 50 | 9, 51, 16, 54
4, 58, 5, 63 | 8, 62, 1, 59
21, 47, 20, 42 | 17, 43, 24, 46
36, 26, 37, 31 | 40, 30, 33, 27
53, 15, 52, 10 | 49, 11, 56, 14

(γ)

60, 2, 61, 7, 64, 6, 57, 3
45, 23, 44, 18, 41, 19, 48, 22
21, 47, 20, 42, 17, 43, 24, 46
4, 58, 5, 63, 8, 62, 1, 59
13, 55, 12, 50, 9, 51, 16, 54
28, 34, 29, 39, 32, 38, 25, 35
36, 26, 37, 31, 40, 30, 33, 27
53, 15, 52, 10, 49, 11, 56, 14

166 102 102

(γ)

60	2	61	7	64	6	57	3
45	23	44	18	41	19	48	22
21	47	20	42	17	43	24	46
4	58	5	63	8	62	1	59
13	55	12	50	9	51	16	54
28	34	29	39	32	38	25	35
36	26	37	31	40	38	33	27
53	15	52	10	49	11	56	14

158 166

158 94 94

8, 6, 4, 2
1, 3, 5, 7
8, 6, 4, 2
1, 3, 5, 7
8, 6, 4, 2
1, 3, 5, 7

60, 23, 20, 63
13, 34, 37, 10

64, 19, 24, 59
9, 38, 33, 14

~~46~~, 26
53, 26, 29, 50
4, 47, 44, 7

49, 30, 25, 54.
8, 43, 48, 3.

53, 26, 29, 50
8, 43, 48, 3

49, 30, 25, 54
4, 47, 44, 7

60, 23, 20, 63
9, 38, 33, 14.

64, 19, 24, 59.
13, 34, 37, 10

38, 35, 40, 33

3, 48, 29, 50
8, 43, 26, 53

14
22
36

60, 23, 20, 63
4, 47, 44, 7

1, 3,

38
36
64
32

158
102
56

166
94
72

29

130
63
~~130~~

107

36

166
102
64

32

14, 2, 61, 49

64, 2, 61, 3 60, 6, 57, 7
45, 19, 48, 18, 41, 23, 44, 22
21, 47, 20, 42, 17, 43, 24, 46
5, 58, 5, 63

a, b, c, d
2, 4, 5, 7

10 3
27

A0 | 2, 4, 5, 7
316
40

1, 2, 3, 4
4, 3, 2, 1
4, 3, 2, 1
1, 2, 3, 4

~~14, 2, 61, 53.~~
1, 14, 15, 4
8, 11, 10, 5
12, 7, 6, 9
13, 2, 3, 16

associate

~~14, 2, 61, 53, 10, 6, 57, 4~~

14, 2, 61, 49, 10, 6, 57, 53
45, 33, 30, 18, 41, 37, 26, 22
21, 47, 20, 42, 17, 43, 24, 46
4, 58,

1, 62, 59, 8
48, 19, 22, 41
24, 43, 46, 17
51, 6, 3, 64

1, 62, 24, 43
48, 19, 59, 6
59, 8, 46, 17
22, 40, 3, 64

Q1

26
26
52
20
32

0, 12, 0, 12
4, 8, 4, 8
12, 0, 12, 0
8, 4, 8, 4

42
14
28

64, 19, 24, 59
13, 34, 37, 10

1, 14, 4, 15
8, 11, 5, 10
13, 2, 16, 3
12, 7, 9, 6

1	2	4	3
4	3	1	2
1	2	4	3
4	3	1	2

~~166~~	166
~~94~~	94

~~43~~, 54.
2, 4, 5, 7
18, 20, 21, 23
42, 44, 45, 47
58, 60, 61, 63

Q1

1, 3, 6, 8
17, 19, 22, 24
41, 43, 46, 48
57, 59, 62, 64

Q2

9, 11, 14, 16
25, 27, 30, 32
33, 35, 38, 40
49, 51, 54, 56

Q3

10, 12, 13, 15
26, 28, 29, 31
34, 36, 37, 39
50, 52, 53, 55

Q4

14, 2, 61, 49 | 10, 6, 57, 53
45, 33, 30, 18 | 41, 37, 26, 22
21, 47, 20, 42 | 17, 43, 24, 46
4, 58, 5, 63 | 8, 62, 1, 59
13, 55, 12, 50 | 9, 51, 16, 54
28, 34, 29, 39 | 32, 38, 25, 35
36, 48, 19, 31 | 40, 44, 23, 27
3, 15, 52, 64 | 7, 11, 56, 60

5. The first a priori concept that I would think of is "equality", or sameness — e.g. two fruits, each a "fruit"; two blocks of wood of the same size (in which the size may be neglected if the emphasis is on the "block of wood"). The integers 1, 2, 3 ... follow by abstracting the concept of number n from n fruits, n books, or n blocks etc.

The next a priori concept is that of "larger" or "smaller". The simplest way of knowing this is to compare two sets of same things —

$$n \text{ books and } m \text{ books}, \quad n > m \text{ or } m < n, \quad (6)$$

where n, m are integers.

In fact this obvious concept of larger or smaller is there in everybody's mind for continuous matter also — e.g. one book heavier than another. We can always settle the question of which is larger, or smaller, without any weights or "measure", by a balance. In the same way, we can draw two lines, and by superposing them, find out which is longer. (The question of accuracy of this is irrelevant, for we are thinking of the concept of $>$ and $<$, and not quantitate it). In fact, immediately this idea becomes quantized and definite if we compare collections of identical objects, by finding out if $n > m$ or $m > n$; in this case $m = n$ has a meaning, because the least difference permitted is the integer 1.

So, the idea of equality of any two similar quantities (or properties like length, mass) becomes possible only if they are "quantized", and we

(10)

0	9, 11, 14, 16	9, 54, 51, 16	9, 54, 32, 35	10, 12, 13, 15	10, 53, 52, 15	10, 53, 31, 36
16	25, 27, 30, 32	40, 27, 30, 33	40, 27, 49, 14	26, 28, 29, 31	39, 28, 29, 34	39, 28, 50, 13
24	33, 35, 38, 40	32, 35, 38, 25	51, 16, 38, 25	34, 36, 37, 39	31, 36, 37, 26	52, 15, 37, 26
40	49, 51, 54, 56	49, 14, 11, 56	30, 33, 11, 56	50, 52, 53, 55	50, 13, 12, 55	29, 34, 12, 55

Q_3

Q4

134
128
260

66
64
68
62
260

2, 5, 7, 4. 1, 6, 8, 3.
7, 4, 2, 5
4, 7, 5, 2
5, 2, 4, 7

66
64
66
62
258

22
38
62
66
258

neither a nor n

2	61	23	44	1	62	24	43
47	20	58	5	48	19	57	6
60	7	45	18	59	8	46	17
21	42	4	63	22	41	3	64
9	54	32	35	10	53	31	36
40	27	49	14	39	28	50	13
51	16	38	25	52	15	37	26
30	33	11	56	29	34	12	55

(δ). Q's are associated

16 subsquares sum to 130 each

neither a nor n

2	61	44	23	1	62	43	24
47	20	5	58	48	19	6	57
21	42	63	4	22	41	64	3
60	7	18	45	59	8	17	46
9	54	35	32	10	53	36	31
40	27	14	49	39	28	13	50
30	33	56	11	29	34	55	12
51	16	25	38	52	15	26	37

(ε).

Q's assoc. –

51 + 30 + ~~39 + 36~~
60 + 63 + 48 + 43

6

Why not apply this new technique

to the other 8 × 8 squares obtained earlier

4, 5, 4
4, 3, 4
4, 5, 4
4, 3, 4

0. 3, 7, 12, 16	3, 57, 54, 16.	~~3, 57, 29, 39~~	
15. 18, 22, 25, 29	48, 22, 25, 35	~~48, 22, 50, 12~~	
32. 35, 39, 44, 48	29, 39, 44, 18	~~54, 16, 44, 18~~	
47. 50, 54, 57, 61	50, 12, 7, 61	~~25, 35, 7, 61~~	

Q_1 ✓ not m

3, 57, 29, 39
48, 22, 50, 12
54, 16, 44, 18
25, 35, 7, 61

(ε) has all the properties of Fig. 261 of Andrews (Doubtful)

Fig. 115, p. 148 of max. book

~~1, 5, 8, 12~~ 1, 5, 12, 16
19, 23, 26, 30
33, 37, 44, 48
51, 55, 58, 62.

(δ) has properties 1, 2, 3, ~~but~~ 5 (modified) but not 4 of Fig 261

~~has~~ properties 1, 2, 3 modified to be semi-magic

a property 4, 7 (modified)

a property 10 (to be examined) of Fig. 265

& property 1 of Fig. 267 (i.e. ~~4-ply~~ 16 ~~....~~ exceptions).

3, 57, 54, 16
48, 22, 25, 35
29, 39, 44, 18
50, 12, 7, 61

3, 57, 29, 39
48, 22, 50, 12
54, 16, 44, 18
25, 35, 7, 61

& (ε)

To get (δ) from (α) what I have done is

(i) to interchange 1st two cols with last two cols. & get (β)

(ii) to interchange 3rd & 6th rows, 4th & 5th rows in (β) to get (γ)

(iii) on (γ) arrange Q_1, Q_2, Q_3, Q_4 to get magic squares using Kraitchik's (A+a, B+b, ..) rule

& unexpectedly got (δ) in which these quadrants were associated magic squares.

(iv) Next using Planck's rule for a → n for the quadrants, got the quadrants nasiks, in (ε)

the ... property holds except for a few exceptions.

Both (δ) & (ε) are neither a nor n & ~~......~~ K-n property is lost & 4-ply property holds except for a few exceptions.

Why not try (iii) & (iv) directly for α? This has been done for Q_1 which becomes a magic square neither a nor n.

not an addition table (A+D = B+C & a+d = b+c)

although

Now Q_2

0
17
32
49

2, 6, 9, 13	→	2, 60, 55, 13	Q_3 written as 1, 5, 10, 14	→ 1, 59, 56, 14
19, 23, 28, 32		45, 23, 28, 34	20, 24, 27, 31	→ 46, 24, 27, 33
34, 38, 41, 45		32, 38, 41, 19	33, 37, 42, 46	31, 37, 42, 20
51, 55, 60, 64		51, 9, 6, 64	52, 56, 59, 63	52, 10, 5, 63

Q_2 magic

Q_3 magic

Q_4 = 4, 8, 11, 15	→	4, 58, 53, 15
17, 21, 26, 36		47, 21, 26, 36
36, 40, 43, 47		30, 40, 43, 17
49, 53, 58, 62		49, 11, 8, 62

Q_4 magic ✓

not a rule of application

obviously magic

3	57	54	16	2	60	55	13
48	22	25	35	45	23	28	34
29	39	44	18	32	38	41	19
50	12	7	61	51	9	6	64
1	59	56	14	4	58	53	15
46	24	27	33	47	21	26	36
31	37	42	46	30	40	43	17
52	10	5	63	49	11	8	62

Omit this

Q's also magic neither a nor n

(A) neither a nor n.

not 2×ply

nor K-n.

52 + 42 + 47 + 53
50 + 44 + 45 + 58 = 388

16 subsquares sum to 130

each quadrant has four 3 × 3 squares whose corner nos sum to 130

Also property 5 of Andrews Fig. 261

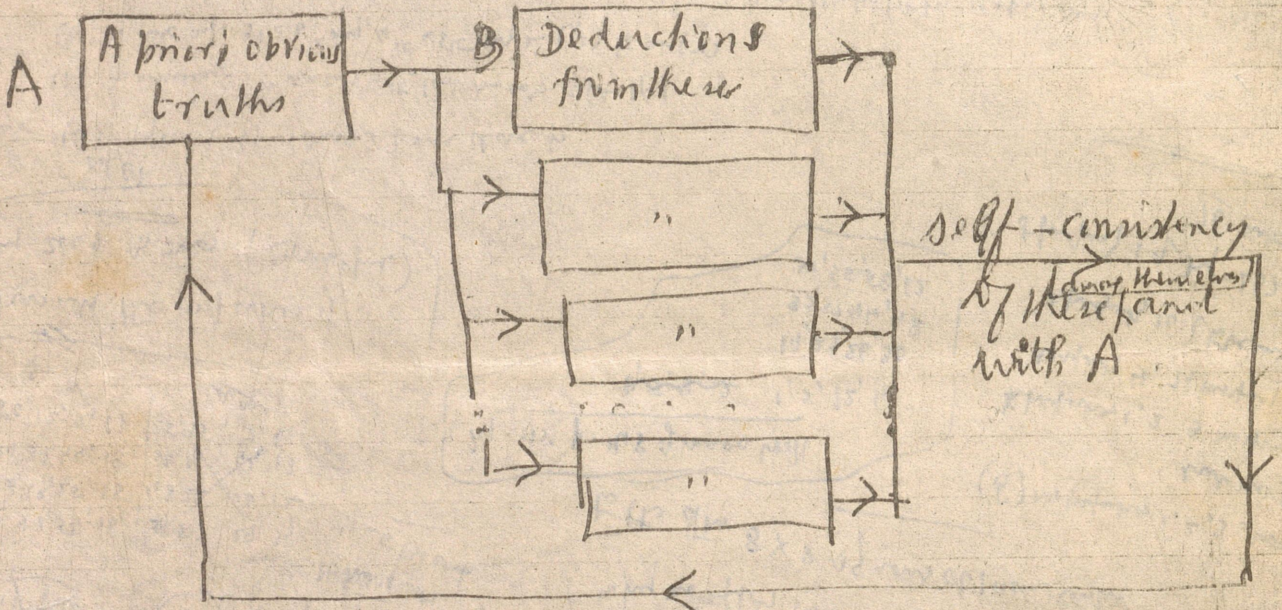
i.e. (A) has all the properties of Fig. 261

except that the Q's are not associated

B + C

26, 30
23, 32

in any field of knowledge, including mathematics, there are first of all some "self-evident truths" or "axioms" if we would like to call them that way. Often, these are used to build a body of knowledge ~~bit by bit~~, and afterwards one* comes back to the axioms and tries to justify them or at least show that ~~it is~~ they are not inconsistent with anything that follows. So, the method of expanding knowledge has the following block diagram:



~~So~~ Obviously, it will be a stupendous task to make this type of analysis for mathematics. So, we shall take the logical structure of mathematics as it exists now for granted, and only ~~see~~ try to verify where the theorems, or postulates, of type A and deductions, of type B, in the above block diagram, need any modification, improvement, or clarification, if they must fit the intuitive ideas of physicists, or the requirements of theories, ~~So~~, of physics.

Getting (δ) with Q's associated was a fluke & hence getting ~~(ε)~~ (ε) with Q's nasik also a fluke.

It would be wonderful if we could get a square which is n & also Q's n. Is this possible?

Yes. See ~~Planck's~~ Fig. 695, p. 377 of Andrews.

Splitting up (δ)

2	5	7	4	1	6	8	3
7	4	2	5	8	3	1	6
4	7	5	2	3	8	6	1
5	2	4	7	6	1	3	8
1	6	8	3	2	5	7	4
8	3	1	6	7	4	2	5
3	8	6	1	4	7	5	2
6	1	3	8	5	2	4	7

0	56	16	40	0	56	16	40
40	16	56	0	40	16	56	0
40	16	56	0	40	16	56	0
56	0	40	16	56	0	40	16
16	40	0	56	16	40	0	56
8	48	24	32	8	48	24	32
32	24	48	8	32	24	48	8
48	8	32	24	48	8	32	24
24	32	8	48	24	32	8	48

Fig. 115, p. 148 of main book.

Q_1 is

1, 5, 12, 16	1, 58, 55, 16	magic but
19, 23, 26, 30	48, 23, 26, 33	neither n nor n
33, 37, 44, 48	30, 37, 44, 19	
51, 55, 58, 62	51, 12, 5, 62	

Andrews Fig. 94, p. 43.

Q_1 is

1, 2, 9, 10	1, 61, 54, 10	not magic
19, 20, 27, 28	48, 20, 27, 39	
~~29, 28, 35, 36~~	28, 40, 47, 19	
~~27, 28, 39, 40~~	53, 9, 20, 62	
~~42, 43, 61, 62~~	Does not appear to	
39, 40, 47, 48	be able to associated	
53, 54, 61, 62	square	

Fig. 449, p. 258 Andrews.

Q_1

1, 2, 3, 4	1, 59, 58, 4	Not a magic square
13, 14, 15, 16	52, 14, 15, 53	at all
53, 54, 55, 56	16, 54, 55, 13	
57, 58, 59, 60	57, 3, 2, 60	

1, 2.

(1, 2) (1, 3), (1, 4) (1, 1)
~~(2, 1) (2, 3)~~
(2, 3), (2, 4)

32 + 56 + 39 + 15 + 23 + 63 + 48 + 8 = 284 × (2, 1)
32 + 7 + 48 + 64 + 23 + 16 + 39 + 55 = 284 × (2, −1)
32 + 27 + 18 + 21 + 31 + 28 + 17 + 22 = 196 × (1, 2)
32 + 20 + 18 + 30 + 31 + 19 + 17 + 29 = 196 × (1, −2)

Suppose in this we change the nasik Q's into associated Q's by Planck's rule

10, 51, 54, 15	12, 49, 56, 13
23, 46, 43, 18	21, 48, 41, 20
47, 22, 19, 42	45, 24, 17, 44
50, 11, 14, 55	52, 9, 16, 53
26, 35, 38, 31	28, 33, 40, 29
7, 62, 59, 2	5, 64, 57, 4
63, 6, 3, 58	61, 8, 1, 60
34, 27, 30, 39	36, 25, 32, 37

This is no longer nasik or associated

We can transfer the total square 695 also into an associated one by Planck's rule because Fig. 695 is constructed on my rule (A, A', A, A' …) (B, B', B, B') in (Q_1, Q_3) & (Q_2, Q_4)

Doing this by quadrant Q's

10	51	15	14	56	13	49	12
23	46	18	43	41	20	48	21
50	11	55	14	16	53	9	52
47	22	42	19	17	44	24	45
63	6	58	3	.	.		
34	27	39	30				
7	62	2	59				
26	35	31	38				

no because this applies only if (A & B) together ~~A only~~ not A & B separately in my rule

It applies to quadrants all right because Q's have (A, A', A, A') & (B, B', B, B') separately

Also applies for (A, A', B, B') in Q_1 (rep)

In Fig. 120 of main Book, p. 153

Can we make the Q's associated?

Q_1 1, 2, 3, 4. 1, 3, 13, 16 No.
17, 19, 28, 32
34,

n w.r.t. 0 4 e

~~0000~~ 00 ~~ee~~ eeoo
eeoo

1, 4, 4, 1	0 12 0 12	1, 16, 4, 13
4, 1, 1, 4	12 0 12 0	16, 1, 13, 4
1, 4, 4, 1	12 0 12 0	
4, 1, 4, 4	0 12 0 12	

1, 4, 2, 3	0 4 0 4	1, 8, 2, 7	1, 4, 3, 2	1, 12, 15, 6
2, 3, 1, 4	12 8 12 8		3, 2, 1, 4	Nrep
4, 1, 3, 2	4 0 4 0		4, 1, 2, 3	
1, 4, 2, 3	8 12 8 12		2, 3, 4, 1	
2, 3, 1, 4				

1, 4
2, 3

1	4	3	2
2	3	4	1
4	1	2	3
3	2	1	4

1, 8, 15, 10
14, 11, 4, 5
12, 13, 6, 3
7, 2, 8, 16

1, 4, 1, 4 | 1, 12, 13, 8
3, 2, 3, 2 | 15, 6, 3, 10
4, 1, 4, 1 | 4, 9, 16, 5
2, 3, 2, 3 | 14, 7, 2, 11
n | 1, 12, 14, 9

1, 4, 2, 3 | 1, 12, 14, 9
3, 2, 4, 1 | 15, 6, 4, 12
3, 1, 3, 2 | 8, 13, 3, 11
4, 1, 1, 4 | 10, 3, 5, 16
2, 3, 1, 4

1, 4, 4, 1 | 1, 12, 14, 9
3, 2, 4, 4 | 13, 16, 7
~~3, 1, 3, 2~~ | 13, 8, 16, 5
3, 2, 2, 3 | 3, 10, 8, 11

1, 4, 4, 1
2, 3, 3, 2
4, 1, 1, 4
3, 2, 2, 3

1, 4, 4, 1 | 1, 12, 16, 5
3, 2, 2, 3 | 15, 6, 2, 11
4, 1, 1, 4 | 16, 5, 1, 12
2, 3, 3, 2

1, 4, 1, 4 | 1, 12, 13, 8
3, 2, 3, 2 | 15, 6, 3, 10
4, 1, 4, 1 | 4, 9, 16, 5
2, 3, 2, 3 | 14, 7, 2, 11

finally must come back to physics. "Dust thou art, to dust returneth" — "was not spoken of the soul"? — Is that (latter) true of mathematics? — Can it reign supreme without the background of knowledge from the sense organs? Pure mathematicians say so. — that they are allowed to follow their nose anywhere they want, and, once the idea of number and measure and operations are introduced, they are at liberty to allow their minds to roam unfettered by restrictions of reality. I am not saying that they shouldn't; but the purpose of this series of talks is to analyse what limitations should be put on the liberties that they can take, if the quantities they measure should pertain to real objects, that is, correspond to "physical reality."

In this, I shall, for the first part, limit myself to the idea of "measure" and of "functions." Afterwards, if possible, we shall expand the range to include "operators" as well — the only exceptions are the operations of differentiation and integration, which are so fundamental to the idea of a function, so that we must introduce them right in the beginning.

4. So, let us get down to brass tacks. The first topic I shall take up is — what is the mathematical nature of physical "quantity"? Before discussing it in detail, I will first state a logical proposition, which I think is true, and which must be accepted, if we wish to avoid running in circles. This is that,

(12)

1, 4, 10, 13
15, 16, 25, 28
34, 39, 50, 53
55, 56, 58, 63

1, 58, 56, 135 | 132 | 128
53, 16, 25, 34 | 128
28, 39, 50, 15 | 132
55, 10, 4, 63 | 132
137, 123, 135, 125

1, 58, 56, 15
55, 16, 25, 34
28, 39, 50, 13 no
53, 10, 4, 63
137, 123, 135, 125

1, 2, 3, 4, 5, 6, 7, 8

Figs. 138, 139 & 140

63 + 39 + 5 + 29 + 47 + 55 + 21 + 13 = 272 X

1	2	8	7	3	4	6	5
8	7	1	2	6	5	3	4
1	2	8	7	3	4	6	5
8	7	1	2	6	5	3	4
1	2	8	7	3	4	6	5
8	7	1	2	6	5	3	4
1	2	8	7	3	4	6	5
8	7	1	2	6	5	3	4

Fig. 138

0	56	0	56	0	56	0	56
8	48	8	48	8	48	8	48
56	0	56	0	56	0	56	0
48	8	48	8	48	8	48	8
16	40	16	40	16	40	16	40
24	32	24	32	24	32	24	32
40	16	40	16	40	16	40	16
32	24	32	24	32	24	32	24

Fig. 139.

1, 8 – 2, 7, 3, 6 – 4, 5
3, 6 – 4, 5

1.8 – 2.7, 5.4 – 6.3

X

40 + 48 + 30 + 22 + 56 + 64 + 14 + 6 = 280

1	58	8	63	3	60	6	61
16	55	9	50	14	53	11	52
57	2	64	7	59	4	62	5
56	15	49	10	54	13	51	12
17	42	24	47	19	44	22	45
32	39	25	34	30	37	27	36
41	18	48	23	43	20	46	21
40	31	33	26	38	29	35	28

Fig. 140.

1, 58, 63
57, 2, 7
56, 15, 10

$\frac{8 \times 17}{2}$ 136 34 $\frac{36}{4} = 9$

$\frac{8 \times 9}{2}$

nasik

1, 58, 63, 8 | 3, 60, 61, 6
16, 55, 50, 9 | 14, 53, 52, 11
56, 15, 10, 49 | 54, 13, 12, 51
57, 2, 64 | 59, 4, 5, 62
17, 42, 47, 24 | 19, 44, 45, 22
32, 39, 34, 25 | 30, 37, 36, 27
40, 31, 26, 33 | 38, 29, 28, 35
41, 18, 23, 48 | 43, 20, 21, 46

nasik, 4 ply,

~~1, 58, 63~~

1, 58, 8, 63
16, 55, 9, 50
57, 2, 64, 7

1, 58, 63, 8
16, 55, 50, 9
56, 15, 10, 49
57, 2, 7, 64

	1	4	10	11
0	1	4	10	11	28
17	18	21	27	28
37	38	41	47	48
52	53	56	62	63

1, 4, 10, 11
18, 19, 25, 28
35, 39, 45, 48
53, 56, 62, 63

1, 62, 56, 11
48, 19, 25, 38
28, 39, 45, 18
53, 10, 4, 63

64 64
64 64

1, 2, 28, 39
48, 19, 53, 10
56, 11, 45, 18
25, 38, 63

0
8
48
56

1, 2, 7, 8
9, 10, 15, 16
49, 50, 55, 56
57, 58, 63, 64

1, 2, 9, 10
19, 20, 27, 28
39, 40, 47, 48
53, 54, 61, 62

2.

1, 63, 58, 8
56, 10, 15, 49
16, 50, 55, 9
57, 7, 2, 64

	1	2	9	10
0	1	2	9	10
18	19	20	27	28
38	39	40	47	48
52	53	54	61	62

1, 63, 8, 58
56, 10, 49, 15
57, 7, 64, 2
16, 50, 9, 55

1, 61, 54, 10
48, 20, 27, 39
28, 40, 47, 19
53, 9, 2, 62

1, 61, 28, 40
48, 28, 53, 9
54, 10, 47, 19
27, 39, 2, 62

1, 63, 58
16, 50, 9, 55
57, 7, 64, 2
56, 10, 49, 15

1, 58, 8, 63
16, 55, 9, 50
57, 2, 64, 7
56, 15, 49, 10

18, 23, 25
7, 12, 16

So, we reformulate the equations connecting physically ~~interesting~~ relevant quantities (vanables) into different forms in terms of Q, a complex number, equal to a + ib. Now, ~~what~~ I now say may look trivial — but it is a mystery that always makes me stand in awe — the equations in terms of ~~the~~ complex Q, when solved by mathematical methods of complex variables (theory), finally give results as a function of (a + ib); but then these, when "decoded" in terms of q and α, agree with observation, or facts.

In other words, once a problem in physics is formulated in terms of mathematics, thereafter mathematical rules can be applied to them, without any rechecking with the facts, and results can be derived for application to practical things. Thus, the "laws" of mathematics, pure products of the human mind, as it, of course, are in full consonance with the interrelationships between different aspects of Nature, which become available to man *via* his sense organs. It is an unstated postulate of science, that the two must agree. In fact, even prior to mathematics, "reason" and "logic", ~~for~~ which occur in the human mind, are consistent with what occurs in natural phenomena in the external world.

3. I shall not dwell further on these philosophical problems, but I have mentioned them to show the intimate relationship between mathematics and physics. Maths arose out of physics and

Fig. 24, p. 165 of Andrews – Convert quadrants into nasiks

1	59	14	56	2	60	15	53
46	24	33	27	47	21	34	28
51	9	64	6	50	12	63	5
32	38	19	41	31	37	18	44
~~38~~ 3	57	46	54	4	58	13	55
~~36~~ 9	~~15~~ 22	35	25	45	23	36	26
49	11	62	28	52	10	61	7
30	40	~~20~~ 17	43	29	39	20	42

~~1, 5, 6, 8, 2, 4, 7, 5~~

Resulting square not n

and the square becomes.

2, 5, 4, 8, 7, 3, 6, 2.

Fig. 94, Andrews – associated square.

The Q's are not magic squares, but can made magic by Kraitchik's table.

(Q1)
1, 2, 9, 10
19, 20, 27, 28
39, 40, 47, 48
53, 54, 61, 62

1, 61, 28, 40
48, 20, 53, 9
→ 54, 10, 47, 19
27, 39, 2, 62
magic

(Q2)
7, 8, 15, 16
21, 22, 29, 30
33, 34, 41, 42
51, 52, 59, 60

→
7, 59, 30, 34
42, 22, 51, 15
52, 16, ~~41~~, ~~21~~
29, 33, 8, 60
magic

(Q3)
5, 6, 13, 14
23, 24, 31, 32
35, 36, 43, 44
49, 50, 57, 58

5, 57, 32, 36
44, 24, 49, 13
→ 50, 14, 43, 23
31, 35, 6, 58
magic

(Q4)
3, 4, 11, 12
17, 18, 25, 26
37, 38, 45, 46
55, 56, 63, 64

→
3, 63, 26, 38
46, 18, 55, 11
56, 12, 45, 17
25, 37, 4, 64
magic

1	61	28	40	7	59	30	34
48	20	53	9	42	22	51	15
54	10	47	19	52	16	41	21
27	39	2	62	29	33	8	60
5	57	32	36	3	63	26	38
44	24	49	13	46	18	55	11
50	14	43	23	56	12	45	17
31	35	6	58	25	37	4	64

(X)

Again associated (1) Corners of the 3×3 squares within quadrants add to 130

with quadrants

all magic squares which might be called semi-associated since elements in complementary cells sum to 63 & 67.

Very interesting This is 16-ply but not 4-ply only 16 subsquares of quadrants add to 130

a → n

a		n	
A	$\bar{A}'$	A	A'
A	$\bar{A}'$	A'	A
A'	$\bar{A}$	A'	A
A'	$\bar{A}$	A'	A
A'	$\bar{A}$ →	A	A'
A'	$\bar{A}$	A	A'
A	$\bar{A}$	A'	A
A	$\bar{A}$	A'	A.

Suppose we transform the total square Fig. 94 into a nasik square by Planck's rule

126
126
134
134

98
98
162
162

1, 2, 62, 61 | 8, 7, 59, 60
9, 10, 54, 53 | 16, 15, 51, 52
48, 47, 19, 20 | 41, 42, 22, 21
40, 39, 27, 28 | 33, 34, 30, 29

57, 58, 6, 5 | 64, 63, 3, 4
49, 50, 14, 13 | 56, 55, 11, 12
24, 23, 43, 44 | 17, 18, 46, 45
32, 31, 35, 36 | 25, 26, 38, 37.

nasik allright (Y)

(1) Corner elements of all 3×3 squares add to 130

(2) Corner elements of all 5×5 squares add to 130

(3) " all 7×7 squares add to 130.

16-ply but not 4 ply.

38 26 63 3
11 55 18 46
17 45 12 56
64 4 37 25

126 134
126 134
134 126
134 126
126 134
126 134
134 126
134 126

98 98 . 162 . 162 . 98 . 98 . 98
162 162 . 98 . 98 . 162 . 162 . 162

4 3 63 64
12 11 55 56
45 46 18 17
37 38 26 25

Suppose we transform (X) into a nasik by Planck's rule

1, 61, 28, 40 | 34, 30, 59, 7
48, 20, 53, 9 | 15, 51, 22, 42
54, 10, 47, 19 | 21, 41, 16, 52
27, 39, 2, 62 | 60, 8, 33, 29

31, 35, 6, 58 | 64, 4, 37, 25
50, 14, 43, 23 | 17, 45, 12, 56
44, 24, 49, 13 | 11, 55, 18, 46
5, 57, 32, 36 | 38, 26, 63, 3

nasik (Z).

nasik. Quadrants all magic squares which are semi-~~magic~~ associates

(1) Corner of 3×3 squares inside quadrants add to 130

16-ply but not 4-ply

all corners of all 5×5 squares add to 130

~~1, 61, 40, 28~~
~~48, 20, 9, 53~~
~~27, 39, 62, 2~~
~~54, 10, 19, 47~~

1, 7, 10, 16
19, 21, 28, 30.
33, 39, 42, 48
51, 53, 60, 62

1, 60, 53, 16
48, 21, 28, 33
30, 39, 42, 19
51, 10, 7, 62

Is (X) K-n? no

31 + 43 + 46 + 26 + 27 + 47 + 42 + 30 = 292

Is (Y) K-n.?

32 + 43 + 56 + 3 + 40 + 19 + 16 + 59 = 268

Is (Z) ~~nasik~~ K-n? no

5 + 49 + 17 + 37 + 27 + 47 + 15 + 59 = 256

1, 61, 40, 28
48, 20, 9, 53
27, 39, 62, 2
54, 10, 19, 47

semi-nasik

which I wish to discuss further. In this case, the idea of an algebraic polynomial equation with integral coeffts was considered in a general way. e.g. ~~x~~ many

quadratic eqn: $x^2-2x+3=(x-3)(x+1)$ has $x=3,-1$. (1)

as roots. We know the general solution for

$$ax^2+bx+c=0 \text{ as } x=\frac{-b\pm\sqrt{b^2-4ac}}{2a} \qquad (2)$$

In the school, we were told that, if b^2-4ac is $-ve$, there is "no solution", and we believed it. But, can we generalize the rule that a quadratic equation always has 2 roots? This leads to i in the soln of the equation

$$x^2=-1, \qquad x=+i,-i \qquad (3)$$

& the wonder is that, just this one new entity, with the rules, $i^2=-1$, is sufficient for the solution of all ~~algebraic~~ equations (polynomials) of degree n, if n is finite. ~~Once~~

Once we learn about i, thereafter we take it for granted in mathematics. But what is its relation to physics? or "reality"? In Nature, all measured quantities are real, — so, if i occurs, in

$$q=a+ib \qquad (4a)$$

then $\quad |q|^2=a^2+b^2 \qquad (4b)$

is often the physically measured quantity. In vibns. & wave motion, the phase α, given by

$$\alpha=\tan^{-1}(b/a) \qquad (4c)$$

is very useful and significant. But, both q & α (given by a, and b) are used in the combination

$$a+ib = q\exp i\alpha = Q \text{ (say)} \qquad (5)$$

In Fig. 143 change quadrants from nasik to associated squares.

1	58	63	8	3	60	61	6
16	55	50	9	14	53	52	11
56	15	10	49	54	13	12	51
57	2	7	64	59	4	5	62
17	42	47	24	19	44	45	22
32	39	34	25	30	37	36	27
40	31	26	33	38	29	28	35
41	18	23	48	43	20	21	46

but the square is no longer nasik. is neither a nor n

but it has properties 1, 2, 3, 4 (better still all 3×3 squares).

cf Fig. 261, p. 165 of Andrews.

To obtain a square neither a nor n

Method 1 (R) of n & (R) of a.

Changing semi-associated squares

Ex. 1

Transforming Fig. 144 into a square with quadrants semi-nasik (bottom p. 13)

1	61	40	28	7	59	34	30
48	20	9	53	42	22	15	51
27	39	62	2	29	33	60	8
54	10	19	47	52	16	21	41
5	57	36	32	3	63	38	26
44	24	13	49	46	18	11	55
31	35	58	6	25	37	64	4
50	14	23	43	56	12	17	45

neither a nor n, Q's are semi-nasik
the quadrants

(1) All sixteen 2×2 squares cont 130 with many other such subsquares.

50 + 58 + 3 + 21 + 27 + 9 + 7 + 12 × not-n

~~Ramanujan's theorem about determinant of 4th order nasik square~~

a, b, c, S − (a+b+c).

S − a, S − b, S − c, c + a

a, b, c, S − (a+b+c)

S, S, S, S − a.

1, 2, 4, 6

~~3, 5, 7, 8~~

8, 7, 5, 3

1, 2, 4, 6, 3, 5, 7, 8
8, 7, 5, 3, 6, 4, 2, 1
1, 2, 4, 6, 3, 5, 7, 8
8, 7, 5, 3, 6, 4, 2, 1
8, 7, 5, 3, 6, 4, 2, 1
1, 2, 4, 6, 3, 5, 7, 8
8, 7, 5, 3, 6, 4, 2, 1
1, 2, 4, 6, 3, 5, 7, 8

38
8, 7, 5, 3, 1, 2, 4, 6
1, 2, 4, 6, 8, 7, 5, 3
8, 7, 5, 3, 1, 2, 4, 6
1, 2, 4, 6, 8, 7, 5, 3
8, 7, 5, 3, 1, 2, 4, 6
1, 2, 4, 6, 8, 7, 5, 3
8, 7, 5, 3, 1, 2, 4, 6
1, 2, 4, 6, 8, 7, 5, 3

56, 0, 56, 0, 56, 0, 56, 0
48, 8, 48, 8, 48, 8, 48, 8
32, 24, 32, 24, 32, 24, 32, 24
16, 40, 16, 40, 16, 40, 16, 40
0, 56, 0, 56, 0, 56, 0, 56
8, 48, 8, 48, 8, 48, 8, 48
24, 32, 24, 32, 24, 32, 24, 32
40, 16, 40, 16, 40, 16, 40, 16

57, 2, 60, 6, 59, 5, 63, 8
56, 15, 53, 11, 54, 12, 50, 9
33, 26, 36, 28, 35, 29, 39, 30
24, 47, 21, 43, 22, 44, 18, 41
8, 63, 5, 59,

3, 5, 7, 8, 6, 4, 2, 1
6, 4, 2, 1, 3, 5, 7, 8
3, 5, 7, 8, 6, 4, 2, 1
6, 4, 2, 1, 3, 5, 7, 8
3, 5, 7, 8, 6, 4, 2, 1
6, 4, 2, 1, 3, 5, 7, 8
3, 5, 7, 8, 6, 4, 2, 1
6, 4, 2, 1, 3, 5, 7, 8

17, 42, 20, 46, 19, 45, 23, 48
40, 31, 37, 27, 38, 28, 34, 25
49, 10, 52, 14, 51, 13, 55, 16
64, 7, 61, 3, 62, 4, 58, 1
48, 23, 45, 19, 46, 20, 42, 17
25, 34, 29, 38, 27, 37, 31, 40

X rep

Physical Mathematics. [Not Revised]

Lecture I. Infinity with Nature of continuity of functions.

1. What is mathematics? A science dealing in the abstract with the nature of things. Anything can be measured, either as a number (integer), or a quantity (real number). [We shall not go into a priori defns etc, which we shall consider later. Now, assume we know mathematics & physics, & we deal with the relation between maths & phys, or the logistics of the mathematical representation and analysis of physical phenomena.]. Then relations between different quantities are represented by functions and it is our purpose to study the properties of functions of various kinds and their interrelationships. These can be expressed by equations (or inequalities more generally, but rarely). The equations are of various types — e.g. algebraic equations, differential equations or functional equations etc. They often represent what may be loosely called "laws" of physics, (or any other experimental science), and solutions of particular problems can be obtained by treating mathematically the input data fed along with the relevant equations.

2. The above is, in general, applied mathematics. In fact, all mathematics arose as applied maths — e.g. the concept of numbers, arithmetic, geometry, algebra, trigonometry, calculus etc. But soon the abstract mathematics could be generalized to situations beyond those directly connected with physical reality — e.g. complex numbers. We shall consider these a little more to make clear a point