OPENING PUZZLE

Arrange the numbers from 1 to 15 in a row so that the sum of any two adjacent numbers is a perfect square.

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

It might be helpful to write the numbers on small slips of paper that you can move around.

M + A + T + H = love

NOTABLE Numbers

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M + A + T + H = love

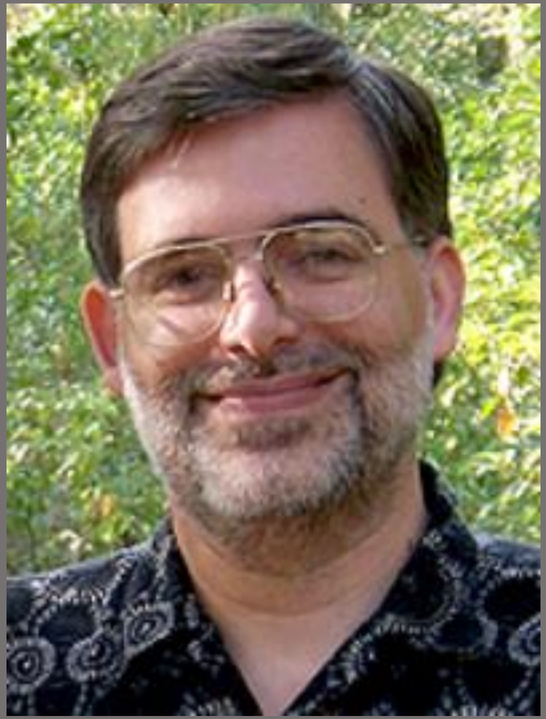
13

M + A + T + H = love

FRIEDMAN NUMBERS

M + A + T + H = love

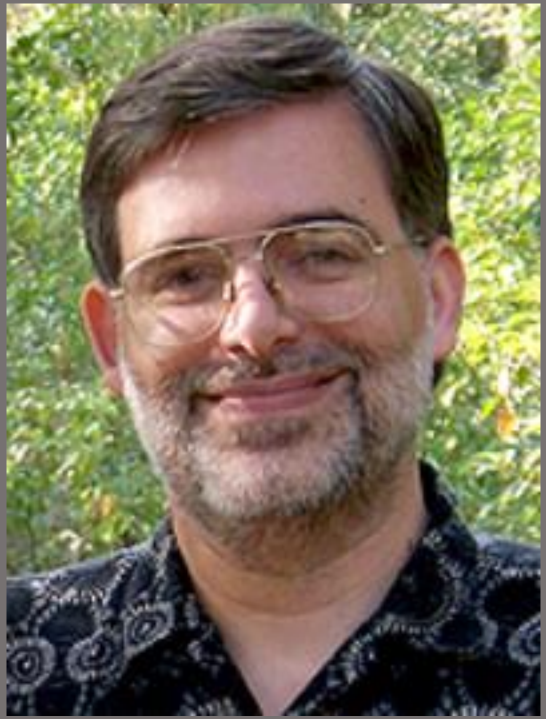
FRIEDMAN NUMBERS



DR. ERICH FRIEDMAN

FRIEDMAN NUMBERS

A Friedman number is a positive integer that can be written in some nontrivial way using its own digits together with the elementary operations (+, -, x, /, exponents, and grouping symbols).



DR. ERICH FRIEDMAN

M + A + T + H = love

FRIEDMAN NUMBERS

Is 13 a Friedman number?

FRIEDMAN NUMBERS

There is only one Friedman number under 100.

FRIEDMAN NUMBERS

There is only one Friedman number under 100.

25

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FRIEDMAN NUMBERS

There is only one Friedman number under 100.

$$25 = 5^2$$

M + A + T + H = love

FIND FIVE MORE

However, there are five Friedman numbers in the 120s. Can you find all five?

FRIEDMAN NUMBERS

Prove that these numbers are Friedman numbers.

- 153
- 216
- 289
- 343
- 347
- 625
- 688
- 736
- 1022
- 1024

M + A + T + H = love

NICE FRIEDMAN NUMBERS

Nice Friedman numbers are Friedman numbers in which the digits in the expression can be arranged to be in the same order as in the number itself.

Which of the Friedman numbers that we have looked at can be written as nice Friedman numbers?

ROMAN NUMERALS

Another area of exploration in the area of Friedman numbers is the use of Roman numerals.

Prove that VIII (8) is a Friedman number in Roman numerals.

Prove that CXXXIV (134) is a Friedman number in Roman numerals.

SOURCES

- *Number Freak : from 1 to 200 : The Hidden Language of Numbers Revealed* by Derrick Niederman – 2009 – Penguin
- NCTM Illuminations – Brainteaser
- Erich Friedman – Problem of the Month – August 2000
- "Finding Friedman Numbers – Stem.org.uk

M + A + T + H = love

HAPPY NUMBERS

M + A + T + H = love

HAPPY NUMBERS

- Pick a number.
- Square each digit and add the result together.
- Use the new number and do the same again.
- If you reach 1, you have a HAPPY NUMBER.
- If you never reach 1, you have a SAD NUMBER.

HAPPY NUMBERS

Is 13 a happy number?

HAPPY NUMBERS

13
$1^2 = 1$
$3^2 = 9$

10
$1^2 = 1$
$0^2 = 0$

1
HAPPY

M + A + T + H = love

HAPPY NUMBERS

- What is the smallest sad number?
- What is the smallest happy prime number?

BREAKOUT ROOMS

What percent of the numbers 1-100 are happy?

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

M + A + T + H = love

EXTENSION TASKS

- Is there an infinite number of happy numbers or is there a largest happy number?
- What is the smallest integer greater than 1 that, when multiplied by any happy number yields another happy number?
- Are there any pairs of consecutive numbers that are both happy? Are there strings of more than two consecutive numbers that are happy?
- What digit does not show up in any of the happy numbers under 100? Why is this? What is the smallest happy number containing this digit?

EXTENSION TASKS

- Does happiness depend on the base in which the number is written?
- What is the maximum number of steps it takes to determine if a number is happy or sad?
- Investigate what happens when you apply the steps but cube the numbers instead of squaring them. What name would you give this type of number?

SOURCES

- MathCounts Problem of the Week Archive – Happy Numbers – August 29, 2016
- Fred and Amy's Maths Shack – Happy Numbers
- "Happy Lessons" by Luke Robinson – *Mathematics Teaching* – September 2006 – Issue 198
- "Happy Integers" by Donald C. Duncan – *The Mathematics Teacher* – November 1972 – Vol 65 Issue 7
- *Numbers are Forever* by Liz Strachan – 2014 – Constable – Pages 107-108

M + A + T + H = love