The Law of Mathemalchemy

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Section 1: Primes

1.1: A prime number is any number that has only two distinct divisors, the number one and itself

1.2: Every natural number other than one is either prime or can be written as a product of primes in a unique way

Section 2: Primitive Counting and Binary Factorization

2.1: A One to One correspondence is an association between two sets so that each member on one set has a unique partner in the other set.

2.2: A graph is a collection of points as well as a collection of arches that connect two points

- A point is a vertex on a graph

- An arch is an edge which connects two points

2.3: When every vertex in a graph is connected to every other, it is known as a complete graph

2.4. To make a ternary tree out of a number, divide the number into two groups of half that number, then repeat, noting when there is a remainder of zero. This is used to determine how to write the number in binary.

2.5: To write a number in Binary Notation, create a ternary tree as described in section 2.4. Then, write down wether the right most number (which should be the remainder after dividing by two) is a one or a zero.

Section 3: Pascals Triangle

3.1: To make a Pascals triangle, simply start with a one, then under it put two ones side by side. Then wherever there are two numbers together, add them and put them below those numbers, to get a pyramid with ones on the sides, and numbers increasing in size towards the middle of the triangle

Ex:

1

1-1

1-2-1

1-3-3-1

1-4-6-4-1

1-5-10-10-5-1

1-6-15-20-15-6-1

3.2: Adding up each number from one row of Pascal’s triangle will always give you a power of two

3.3: When finding the probability of certain events, Pascal’s triangle can show such possibilities (ie, flipping a coin twice gives one possibility of all heads, one possibility of all tails, and two possibilities to have one of each)

Section 4: Mayan and Babylonian numbers:

4.1: To write a number in a base other than ten, always remember the number base you are using. You may never have a symbol meaning a higher quantity than that number minus one.

* Mayans write their nu
* mbers in base 20, so the highest symbol we will use when writing their numbers is what ever they use for our number 19

- Babylonians write their number in base 60, we will never use a symbol higher than what they will use for our number 59

Section 5: Fibonacci Numbers

5.1: To generate the list of Fibonacci Numbers, start your list with two “ones” then add the previous two numbers to get your next one. (Eg, 1, 1, 2, 3, 5, 8, 13…)

5.2: Every number can be written as either a Fibonacci number, or can be written as a sum of non-consecutive Fibonacci numbers in a unique way

Section 6: Symmetry

6.1: A picture has symmetry when a picture can be altered and show the same image as when it was not altered, or when one half of an image exactly overlaps the other half.

* When something has rotational symmetry, it can be rotated and show the exact same picture more than one time.
* When something has reflection symmetry, one half of the object will mirror the other half of the object.
* Every regular shape will have both rotational and reflection symmetry

Section 7: Duality

7.1: A three-dimensional shape is a dual with another when the shape has the same amount of vertices as the other shape’s faces.

* For example, the cube is a dual of the octahedron because the cube has the same number of vertices as the octahedron has faces
* They also have the same number of faces at each vertex and edges with each other

7.2: The tetrahedron is a dual with itself

Section 8: Wall paper groups

8.1: Wallpaper groups are groups of patterned images that resemble certain qualities.

* These qualities depend on how many ways they have both rotational symmetry and reflection symmetry and how that symmetry appears.
* There are a total of 17 groups which have unique qualities regarding both types of symmetry.

Section 9: Fractals

9.1: Fractals are images or objects where there’s a perfect copy of the fractal contained in the fractal

* In order to create a fractal, you first make a rule as to what you wish to do, then you repeat that rule to create the image as you wish.
* As long as you end up with the same item at the end of “it,” it doesn't matter what it actually is
* Therefore, there are many different types of fractals, such as spiral fractals, which copy an image, shrink them, and turn them 90 degrees. It then does that again, infinitely filling the space lost by the shrinking and turning of the copied image
* Additionally, fractals go for an infinite length, while staying within one confined space

Section 10: Mobius Bands and Knots

10.1: A Mobius Band is a band which has at least one twist. If it has an odd number of twists, then it only has one side and one edge. If it has no twists or an even number of twists, it remains with two sides and edges

* If you were to twist the band to the right, you cannot turn it into the Mobius band you would get if you were to twist it to the left
* When you cut a single twisted Mobius band, you get a longer, twice-twisted band.

10.2: If you cut any band other than a once-twisted Mobius band down the middle, you get either a knot or a link.

* A knot has only one actual “band,” which twists itself in as many crossings as the number of times that the band has been twisted.
* A link has the same properties, however, the only difference is that a link has two bands that cross in a way that is impossible to unlink them without destroying one of the bands

10.3: A knot is tri-colorable if at every crossing you can either color each strand three different colors or have all of them be the same color.

* However you must use at least two colors and no more than three
* Reidemister moves do not alter the tri-colorability of a knot and can be used to decipher whether a knot is tri-colorable by removing unnecessary crossings.
* There are an infinite number of knots, so an infinite number of knots are tri-colorable.
* The unlink and the Trefoil knot are the only tricolorable knots created with 5 crossings or fewer.

Section 11: Infinity and Number Sets

11.1 Infinity means that the object being referred to is endless or has an endless quantity

* It is Not a Number and Not a Size
* Because it isn’t a number, adding and subtracting a number to infinity does nothing
* There is also an infinitely many amount of sizes of infinity

11.2: One set of infinity has the same cardinality as another if they have a one-to-one correspondence with each other.

* A set is simply a collection of objects, and a subset is some members of the original set
* A subset is never bigger in size than the set itself
* Pascal’s triangle can tell you how many power sets are in a set

11.3: A power set is the set of all of a set’s subsets in one set.

* The power set of a set of n elements has 2^n elements
* This property holds true for a set containing no elements, as well as all finite and infinite sets