MaPP Challenge '18

Mathematical Puzzle Programs

Version 2017/08/28

MaPP Challenge '18

Part I

Game Overview

MaPP Challenge ’18

Credits

Thanks for downloading the puzzle booklet for **MaPP Challenge ’18** by Mathematical Puzzle Programs. These puzzle materials are provided as-is for use in the classroom (or anywhere else!) to help showcase the fun of mathematical problem-solving.

When the MaPP Challenge ’18 is over, we’d love your feedback on how to improve this booklet. You can contact us by email at info@mappmath.org. Or better yet, submit an issue or pull request at our GitHub page at `https://github.com/MaPPmath` directly.

More information on Mathematical Puzzle Programs may be found at our website `http://mappmath.org` and on our Twitter @MaPPmath. Happy mathematical puzzling!

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Special Thanks

- Ronimo Games, for the use of the Awesomenauts brand and artwork in Puzzle 4.

Attribution

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Civic Duty

Mobimon tamers need your help!

The Mobimon in **Wenge** are running wild! All of the city utilities that are powered by Mobimon are offline. The citizens of Wenge don't have electricity, clean water, or even cell phone signal! **Eight utilities** have been disrupted in total.

1. Electricity, powered by the lightning Mobimon **Electrumble**,
2. water, powered by the moisture Mobimon **Floobles**,
3. traffic lights, controlled by the temporal Mobimon **Tiktok**,
4. garbage, incinerated by the flame Mobimon **Burnie**,
5. cell phone access, routed by the data Mobimon **Ayepey**,
6. sewage, treated by the filter Mobimon **Stankgunk**,
7. street lights, controlled by the photosensitive Mobimon **Forluxi**,
8. and ambulance sirens, controlled by the noisy Mobimon **Sonitus**.

Luckily Wenge has 86 Mobimon tamers on staff and they will need **all of them** to restore service. They've picked up a few tricks for **how many tamers** should work with each different utility Mobimon.

- Forluxi needs the fewest tamers.
- Tiktok needs the most tamers.
- Ayepey and Sonitus need the same number of tamers. No other two Mobimon need the same number of tamers.
- The number of tamers needed by Burnie and Forluxi differ by one.
- Burnie and Ayepey need 9 trainers between the two of them.

The four strongest of the utility Mobimon need some **extra tricks**!

- Each of Electrumble, Floobles, Tiktok, and Stankgunk need a two-digit number of tamers.
- Eletrumble is particularly picky, and needs a perfect square number of tamers.
- Electrumble, Floobles, and Stankgunk each need an even number of tamers.
- The number of tamers needed by Electrumble and the number of tamers needed by Floobles has something in **common**.

- The number of tamers needed by Floobles and the number of tamers needed by Tiktok also has something in **common**.
- The number of tamers needed by Tiktok and the number of tamers needed by Stankgunk also has something in **common**!
- But the number of tamers needed by Tiktok and the number of tamers needed by Electrumble doesn't have much in common.

Every Mobimon adventure is about becoming the very best, and helping out the city of Wenge should tell you something about **what kind of trait a Mobimon champion should have**. Also, the mayor promised to give you his **strongest Mobimon** as a reward! Sweet!

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Main Puzzle ?

Doppl's Unending Enigma

It's time to put your training to the test by trying to befriend **Doppl**! As you might expect, the natural numbers, known as the **finite ordinals** to Mobímon Wranglers, are used to account for a finite amount of Doppl.

- $0 =$ no Doppl
- $1 =$ 
- $2 =$ 
- $3 =$ 
- $4 =$ 

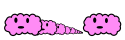
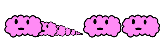
However, the problem is that **infinite** groups of Doppl are quite common out in the wild! Wranglers use the lowercase Greek letter ω ("omega") to represent the shortest possible chain of infinitely-many Doppl.

- $\omega =$ 

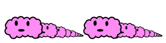
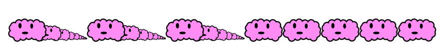
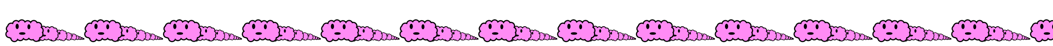
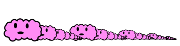
Of course, if they were all the same size, they would quickly run out of space for their Mobímon battles. That's why groups of Doppl will shrink down as necessary to fit into whatever space is available. Here's a more typical representation of ω-many Doppl.

- $\omega =$ 

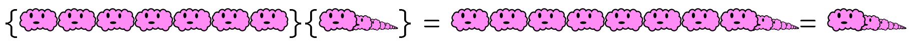
This ω is the first **infinite ordinal**, but it's not the last! You see, bizzare as it sounds, there's always room for another Doppl to join the party.

- $\omega + 1 =$ 
- $\omega + 2 =$ 
- $\omega + 3 =$ 

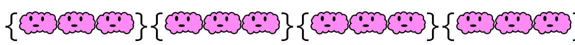
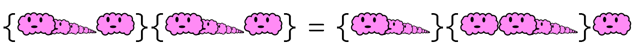
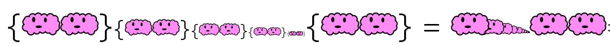
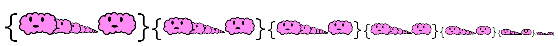
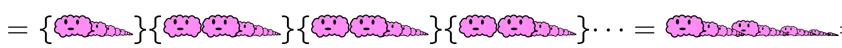
So $\omega + 1, \omega + 2, \omega + 3$ are the next three infinte ordinals. And yes, Wrangers have reported Doppl groups like these as well.

- $\omega + \omega = \omega \cdot 2 =$ 
- $\omega + \omega + \omega + 5 = \omega \cdot 3 + 5 =$ 
- $\omega{+}\omega{+}\omega{+}\cdots = \omega{\cdot}\omega = \omega^2 =$ 
  $=$ 

After the discovery of Doppl, the Mobímon community noticed that the rules of **ordinal arithmetic** behave differently when infinite ordinals are involved. Notice what happens when groups of Doppl are added together: a finite group of Doppl will attach to an infinite group to its right.

- $3+4=$  $=7$
- $7+\omega=$  $=\omega$
- $(\omega\cdot 4+3)+(\omega\cdot 2+5)=$ 
  
  $=\omega\cdot 6+5$

Doppl are also known to multiply. When this occurs, each Doppl in the second factor splits into a copy of the Doppl group given by the first factor. But when infinite groups are around, the normal distribution rules don't apply, so be careful!

- $3\cdot 4=$  $=12$
- $(\omega+1)\cdot 2=$  $=\omega\cdot 2+1$
- $2\cdot(\omega+1)=$  $=\omega+2$
- $(\omega+1)\cdot\omega=$ 
   $=\omega^2$

Can you find the missing values in these Doppl-inspired arithmetic problems?

$$(\omega+3)\cdot(\omega+5)=\omega^2\cdot E+\omega\cdot G+S$$
$$\omega+1+\omega+3+\omega+5+\omega+7=\omega\cdot I+O$$
$$3\cdot\omega+\omega^2\cdot 5+4\cdot(\omega^2+2)=\omega^2\cdot L+\omega\cdot R+N$$
$$2\cdot(2+\omega\cdot 3)+(\omega\cdot 3+2)\cdot 2=\omega\cdot A+M$$

If so, you should be able to decode 24007042951 into a Doppl's favorite Mobímon attack!

Part II

Bonus Puzzle
Gotta snag 'em all in the Expedition Zone!

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Bonus Puzzle

Catch Mobimon in the Expedition Zone!

Take a trip through the **Expedition Zone** to catch as many Mobimon as you can! Theres a catch, though: your path through the Expedition Zone has to follow certain **path pieces.** Here are the rules:

1. Two path pieces are adjacent if at least one square in one piece is orthogonally (**not diagonally**) adjacent to at least one square in the other piece.
2. You must have a path piece adjacent to the **starting line**.
3. You must have a path piece adjacent to the **finish line**.
4. You may not have any breaks in your path. It must be an **unbroken path** of adjacent pieces from start to finish.
5. Your path may cross itself.

You may notice several Mobimon inhabiting the Expedition Zone! These Mobimon are represented by **numbers,** and each number is its **strength.** To catch a Mobimon, you must

1. make sure your path goes over that Mobimon, and
2. a piece on that Mobimon must have **more squares than that Mobimon's strength**.

Your score is the **sum of the strengths of the Mobimon you catch**. The teams with the two highest scores get **Victory Points**! Good luck!

The Expedition Zone

Start

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

Finish

Path Pieces