

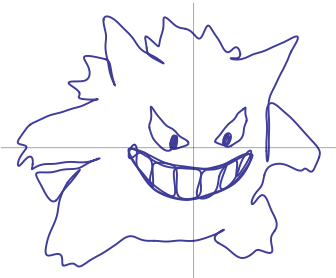
# MATH:1260 Pokémath

## The Mathematics of Pokémon Go<sup>®</sup>

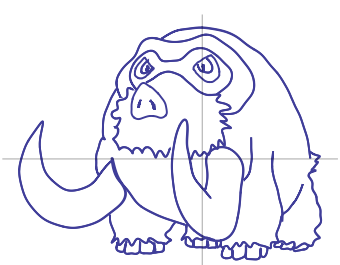
Week 14 Wednesday, Spring 24

Popular curves:

Gengar-like curve



Mamoswine-like curve



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## Plan for Today

- Module 3: To Be The Very Best!
  - Math with Units
    - In Pokemon and in life!

## Reminders

- GW 12 (last GW!) is Thursday.
- HW 9 (last HW!) is due tonight at midnight.
- Project 3 Stage 1 is due tonight at midnight.
- Project 3 Stage 2 is due Wednesday May 1.
  - We will have a battle day on Monday April 29, so you can meet with your rival and battle during class.

An example: Gengar vs Mamoswine



## Moves

### Fast Moves

Gengar uses Hex

Mamoswine uses Powder Snow

Fast Move	Power	Energy	Duration	STAB(1or1.2)	Type	Effectiveness	Multiplier	unrdd damage	damage
Hex	6	12	3	1.2		1	1.56	8.12377358	9
Powder Snow	5	8	2	1.2		1	1.56	6.20670732	7

### Charge Moves

Gengar uses Shadow Ball

Mamoswine uses Avalanche

Charge Move	power	energy	STAB(1or1.2)	Type	Effectiveness	Multiplier	unrdd max d	max damage
Shadow Ball	100	55	1.2		1	1.56	135.396226	136
Avalanche	90	45	1.2		1	1.56	111.720732	112

## Motivational Example: Where do the Units go?

Gengar's Hex charges up 12 energy every three turns.

$$\text{"Energy per Turn"} = \frac{12}{3} \frac{\text{Energy}}{\text{Turn}} = \frac{4}{1} \frac{\text{Energy}}{\text{Turn}}$$

There are two turns every second

$$\text{"Turns per second"} = \frac{2}{1} \frac{\text{Turns}}{\text{Second}} = \frac{2}{1} \frac{\text{Turns}}{\text{Second}}$$

What is the average "energy per second"?

$$\frac{4}{1} \cdot \frac{2}{1} = \frac{8}{1} \frac{\text{Energy}}{\text{Second}}$$

why are there the units?

## Rules for Units

1) The English word “per” signals a rate of change so the units are divided.

Pokemon Examples:

“Damage per turn” =  $\frac{\text{Damage}}{\text{Turn}}$

“Candy per level up” =  $\frac{\text{Candy}}{\text{Level up}}$

Real Life Examples:

“Miles per hour” =  $\text{mph} = \frac{\text{miles}}{\text{hours}}$

“Caffeine per serving” =  $\frac{\text{caffeine}}{\text{serving}}$

Others?  $\frac{\text{GDP}}{\text{capita}}$      $\frac{\text{words}}{\text{minute}}$      $\frac{\text{frames}}{\text{second}}$      $\frac{\text{dollars}}{\text{hour}}$

## 2) When you multiply quantities, you multiply units.

We multiplied two quantities to find “energy per second” earlier. We must also multiply those units!

$$\frac{4}{1} \frac{\text{Energy}}{\text{Turn}} \cdot \frac{2}{1} \frac{\text{Turns}}{\text{second}} = \frac{8}{1} \frac{\text{Energy turns}}{\text{turn seconds}}$$

Another example: one measure of the overall usefulness of a fast move is “Power per turn” \* “Energy per turn”. What do the units look like in this case? How does Hex compare to Powder Snow?

$$\text{Hex: } \frac{6}{3} \frac{\text{Power}}{\text{Turns}} \cdot \frac{12}{3} \frac{\text{Energy}}{\text{Turns}} = \frac{8}{1} \frac{\text{Power Energy}}{\text{Turns}^2}$$

$$\text{Powder Snow: } \frac{5}{2} \frac{\text{Power}}{\text{Turn}} \cdot \frac{8}{2} \frac{\text{Energy}}{\text{Turn}} = \frac{10}{1} \frac{\text{Power Energy}}{\text{Turns}^2}$$

### 3) Units can cancel!

This gives us a way to check our answer on "energy per second".

$$\frac{4}{1} \frac{\text{Energy}}{\text{Turn}} \cdot \frac{2}{1} \frac{\text{Turns}}{\text{second}} = \frac{8}{1} \frac{\text{Energy} \cancel{\text{turns}}}{\cancel{\text{turns}} \text{seconds}} = \frac{8}{1} \frac{\text{Energy}}{\text{second}}$$

Let's follow the units as we calculate damage per turn, turns per cycle and total damage per cycle for Gengar (assume no shields).

Fast Move	Power	Energy	Duration	STAB(1or1.2)	Type Effectiveness	Multiplier	unrdd
Hex	6	12	3	1.2	1	1.56	8.123
Powder Snow	5	8	2	1.2	1	1.56	6.206

Charge Move	power	energy	STAB(1or1.2)	Type Effectiveness	Multiplier	unrdd
Shadow Ball	100	55	1.2	1	1.56	135.396
Avalanche	90	45	1.2	1	1.56	111.720

number of turns to change and use a charged attack

$$\text{dmg per turn: } \frac{9}{3} \frac{\text{dmg}}{\text{turn}} = \frac{3}{1} \frac{\text{dmg}}{\text{turn}}$$

$$\text{turns per cycle: } \frac{55 \text{ energy}}{1 \text{ charge}} \div \frac{4 \text{ energy}}{1 \text{ turn}}$$

$$\approx 14 \frac{\cancel{\text{energy}} \text{ charge}}{\cancel{\text{energy}} \text{ turn}} = 14 \frac{\text{turn}}{\text{charge}}$$

community defined cycles

$$14 \frac{\text{turn}}{\text{charge}} + 1 \frac{\text{turn}}{\text{use}} \Rightarrow \left\{ \frac{\text{turns}}{\text{cycle}} = \frac{\text{turns}}{\text{charge}} + \frac{\text{turn}}{\text{use}} \right\}$$

$$\text{Total dmg per cycle: } 14 \frac{\cancel{\text{turns}}}{\text{charge}} \cdot \frac{3 \text{ dmg}}{1 \cancel{\text{turn}}} + 1 \frac{\cancel{\text{turn}}}{\text{use}} \cdot \frac{136 \text{ dmg}}{\cancel{\text{turn}}}$$

$$= \frac{42}{1} \frac{\text{dmg}}{\text{charge}} + \frac{136}{1} \frac{\text{dmg}}{\text{use}}$$



4) When you try to add (or subtract) terms, make sure the units match.

7 miles + 5 kilometers

These examples may seem silly, but these kinds of mistakes can crash rockets!

<https://www.latimes.com/archives/la-xpm-1999-oct-01-mn-17288-story.html>

5) When you want to change units, you can multiply by “1”.