

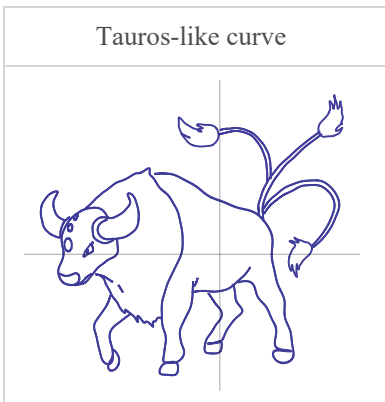
# MATH:1260 Pokémath

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

Week 4 Wednesday, Spring 24

Popular curve:

Tauros-like curve



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## Plan for Today

- CPM and level
  - Inverse functions
  - Not all functions are invertible
  - More methods to find level

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## Class Reminders

- Project 1 Stage 1 due Friday
- Project 1 Stage 2 due Wednesday Feb 14
- GW4 in discussion Thursday (bring a laptop or computer, we will use excel)

chance to redo Project 1  
Stage 1

## CPM and level

<https://gamepress.gg/pokemongo/cp-multiplier>

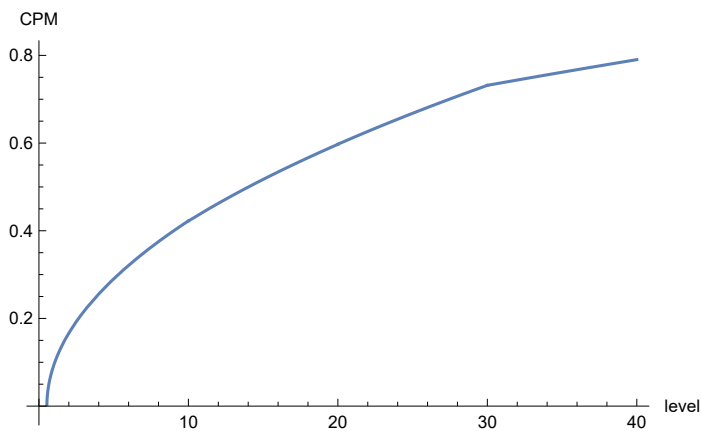
This chart (link on ICON) gives CPM as a function of level.

## CPM is a piecewise defined function.

Piecewise defined functions have a different equation for different parts (disjoint subsets) of the domain.

A big shout out to last year's TA, Quanqi, who deduced these formulas from the table!!!

$$\text{CPM}(\text{level}) = \begin{cases} \sqrt{.01885225 * \text{level} - .01001626} & 1 \leq \text{level} \leq 10 \\ \sqrt{.01783805 * \text{level} - .00012575} & 10 < \text{level} \leq 20 \\ \sqrt{.01784981 * \text{level} - .00010945} & 20 < \text{level} \leq 30 \\ \sqrt{.00891892 * \text{level} + .26781725} & 30 < \text{level} \leq 40 \end{cases}$$



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## Level

How can we determine the level of the Pokemon??? We will investigate 4 methods...

Method 1: The bar across the top (NOT EFFECTIVE: Too hard to tell the difference between Pokemon levels!)

Method 2: HP work back (NOT EFFECTIVE: A single HP stat may have multiple CPM!)

Method 3: Power Up Costs

Method 4: Power Up Costs (Secret Technique)

### Method 3: Power Up Cost



<https://gamepress.gg/pokemongo/cp-multiplier>

lvl	CPM	Power up Cost
2.5	0.192650919	200
3	0.21573247	400
3.5	0.2365726613	400
4	0.25572005	400
4.5	0.2735303812	400
5	0.29024988	600
5.5	0.3060573775	600
6	0.3210876	600

Is power up cost (stardust) a function of level?

output                      input

yes

Is level a function of power up cost (stardust)?

output                      input

no

So this method doesn't work either!

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## Inverse Functions

This is the thread that connects the first 3 methods to find Pokemon level we've worked through this week.

### Intuition

A inverse of a function is when you flip the input and output.

### An example from last week

Function: My phone knows the IVs, so it creates a graph of IVs for the appraisal.

Inverse function: I see the appraisal, so I know the IVs.

Flipped



## Definition

Suppose  $f(x)$  is a function from  $A$  to  $B$  and  $g(x)$  is a function from  $B$  to  $A$ . ( $A$  and  $B$  are sets!) Then  $f(x)$  and  $g(x)$  are called inverse functions if

$$g(f(a)) = a$$

and

$$f(g(b)) = b$$

}  $f(x)$  and  $g(x)$  cancel each other out.

Let's do some examples (inverses flip input and output)

Find the inverse of the following functions:

Input	Output
-1	7
0	6
1	5
2	4

input	output
7	-1
6	0
5	1
4	2

$$h(x) = 3x + 7$$

$$x = 3h(x) + 7$$

$$p(x) = x^2$$

$$x = (p(x))^2$$

Tophat!

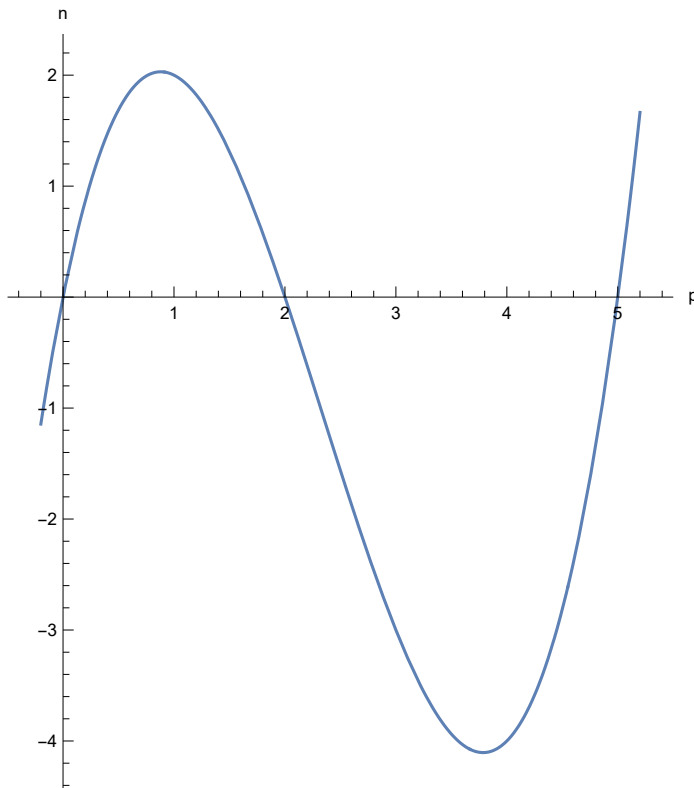


## Graphs of functions (we have seen this before, but there's more to it)

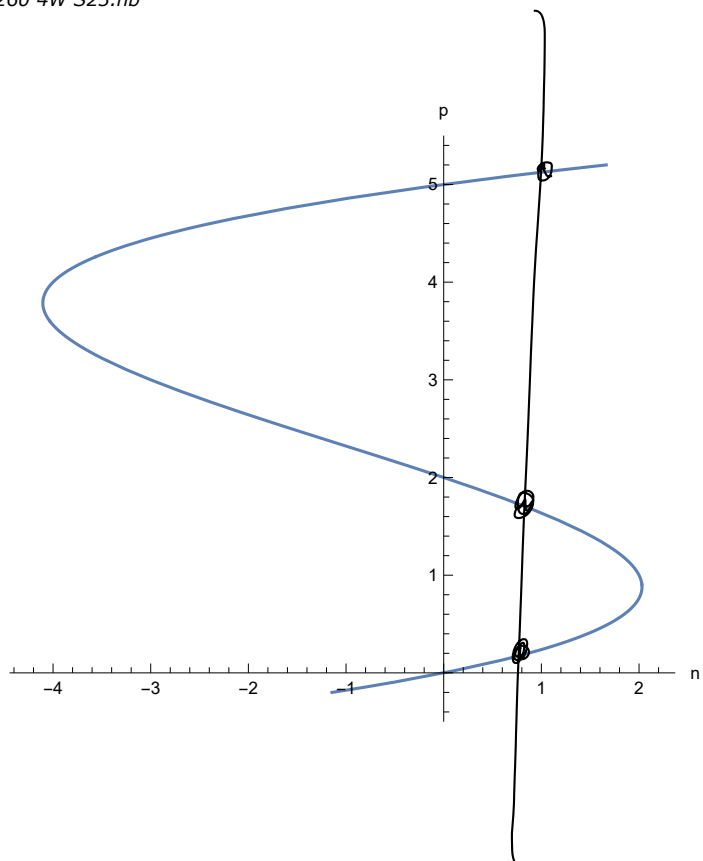
### The Vertical Line Test:

If you can draw a vertical line that intersects the graph twice or more, the graph is NOT a function.

Is  $n$  a function of  $p$ ?



Is  $p$  a function of  $n$ ?

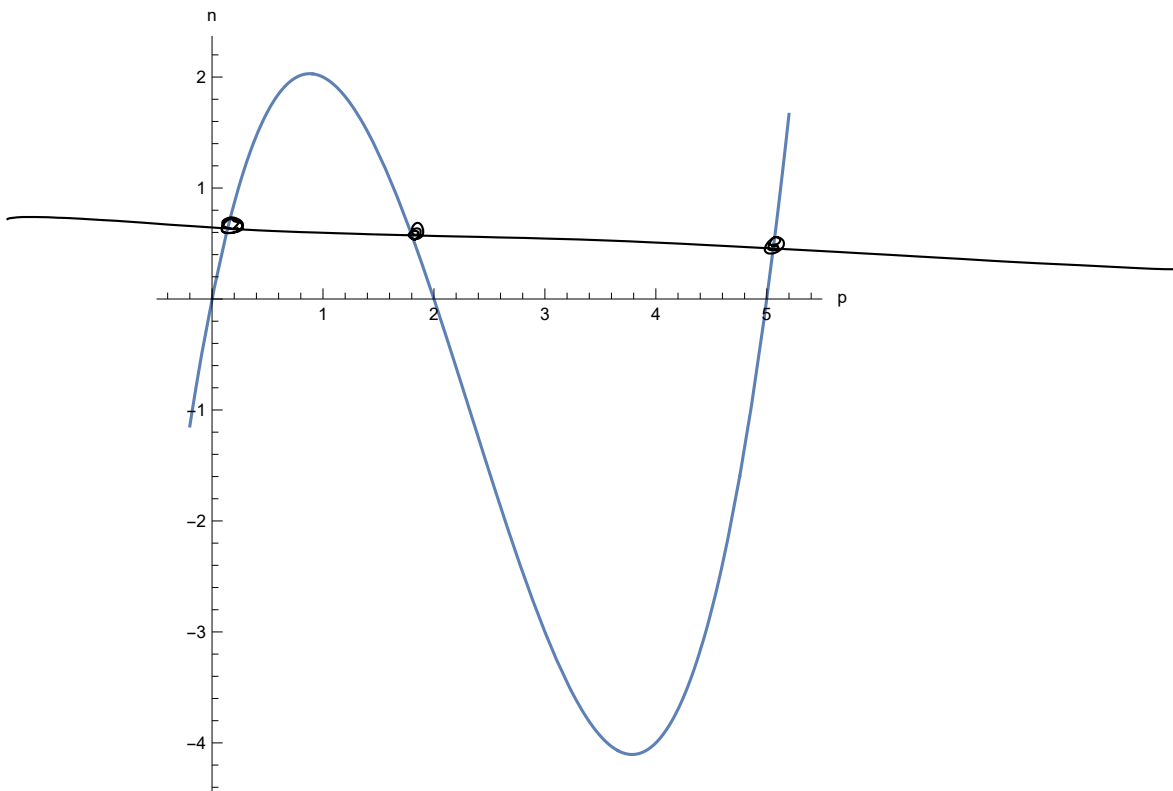


## Graphs of inverse functions

### The Horizontal Line Test:

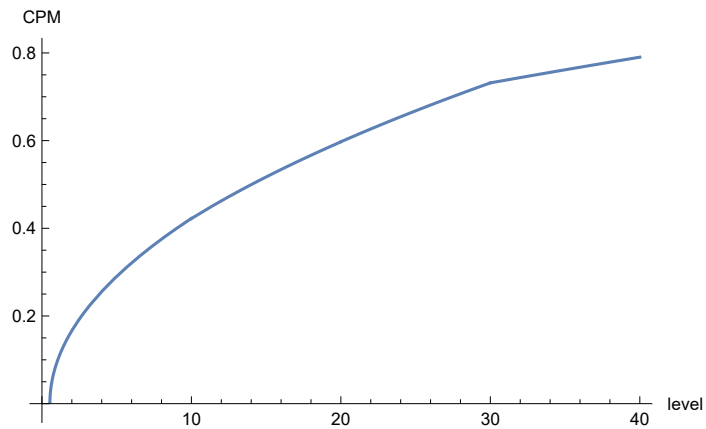
If you can draw a **horizontal** line that intersects the graph twice or more, the graph is NOT **invertible**.

Is this an invertible function?



Is this function invertible?

$$\text{CPM}(\text{level}) = \begin{cases} \sqrt{.01885225 * \text{level} - .01001626} & 1 \leq \text{level} \leq 10 \\ \sqrt{.01783805 * \text{level} - .00012575} & 10 < \text{level} \leq 20 \\ \sqrt{.01784981 * \text{level} - .00010945} & 20 < \text{level} \leq 30 \\ \sqrt{.00891892 * \text{level} + .26781725} & 30 < \text{level} \leq 40 \end{cases}$$



### Method 4: The Secret Technique

<https://gamepress.gg/pokemongo/cp-multiplier>

Check the next 4 power ups  
of your Pokemon.

Take note of the jump between  
each stardust cost.

Compare the full set of 4  
numbers to the chart online.

## The CP Formula!

Now that you know where to find base stats, how to get IVs from appraisal, and the secret technique for finding Pokemon Level, I can finally tell you the CP Formula!

$$CP = \left\lfloor \frac{Attack * \sqrt{Defense} * \sqrt{UnroundedHP}}{10} \right\rfloor$$

$$CP = \left\lfloor \frac{((Base\ Atk + Atk\ IV)CPM) * \sqrt{(Base\ Def + Def\ IV)CPM} * \sqrt{(Base\ HP + HP\ IV)CPM}}{10} \right\rfloor$$