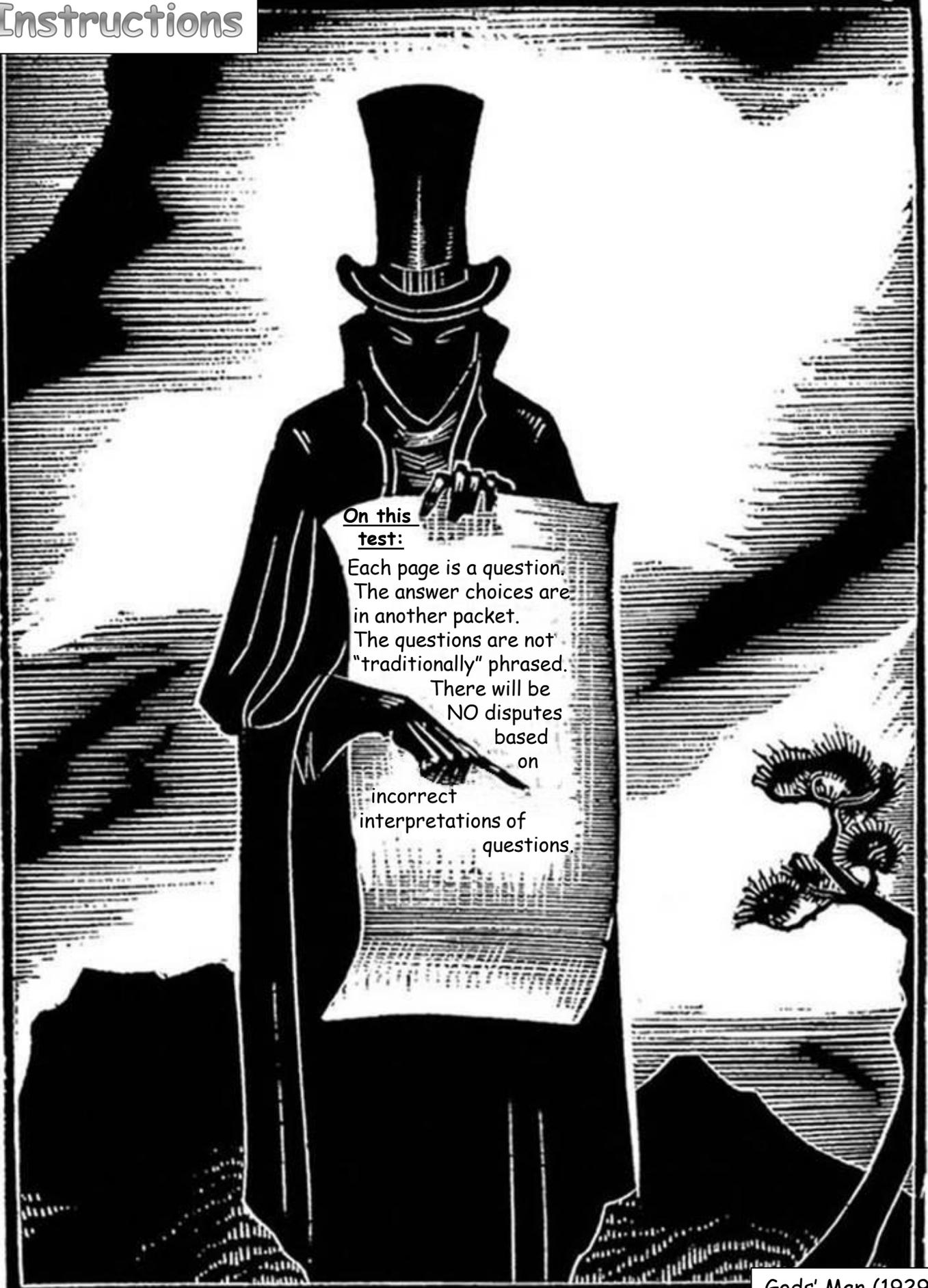


# Instructions



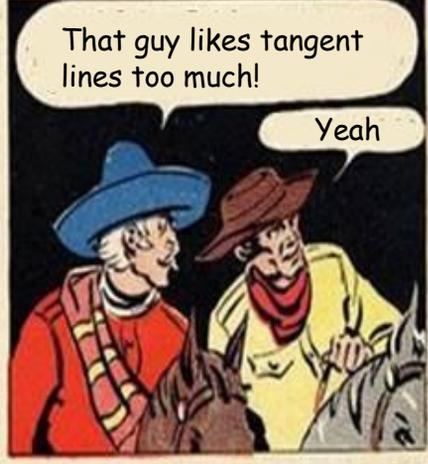
On this test:

Each page is a question.  
The answer choices are  
in another packet.  
The questions are not  
"traditionally" phrased.  
There will be  
NO disputes  
based  
on  
incorrect  
interpretations of  
questions.

# JACK WOODS

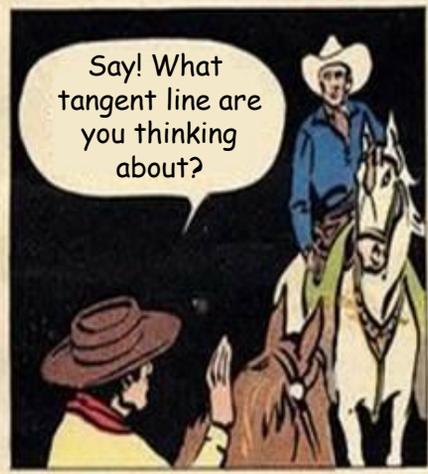


I like tangent lines!

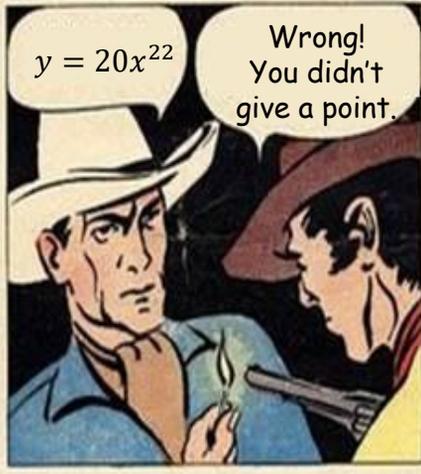


That guy likes tangent lines too much!

Yeah



Say! What tangent line are you thinking about?



$y = 20x^{22}$

Wrong! You didn't give a point.



Tell us everything!

I'm not saying!

You'll tell The Boss!

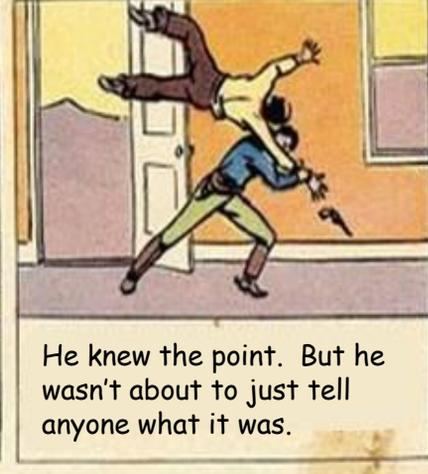


And so they traveled all day and all night to get to the secret ranch of The Boss.

Now you're in for it!



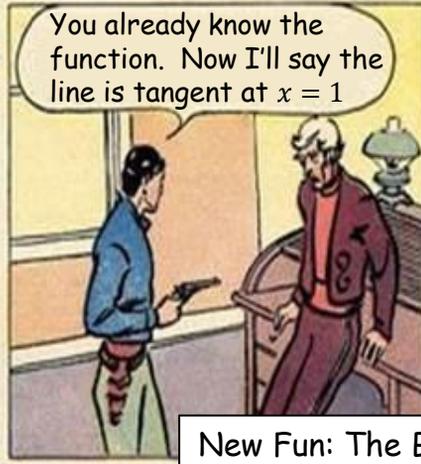
Once again, what point?!



He knew the point. But he wasn't about to just tell anyone what it was.



Instead, the tables are turned!

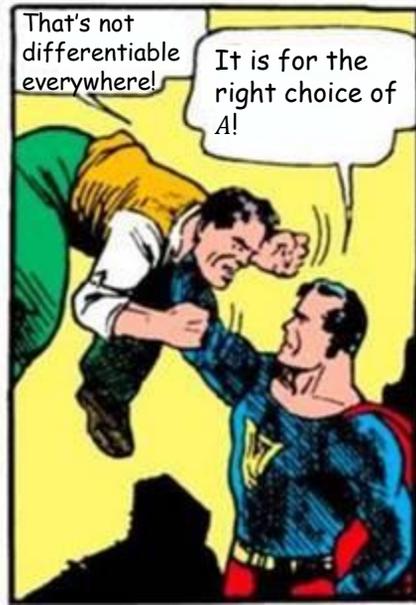
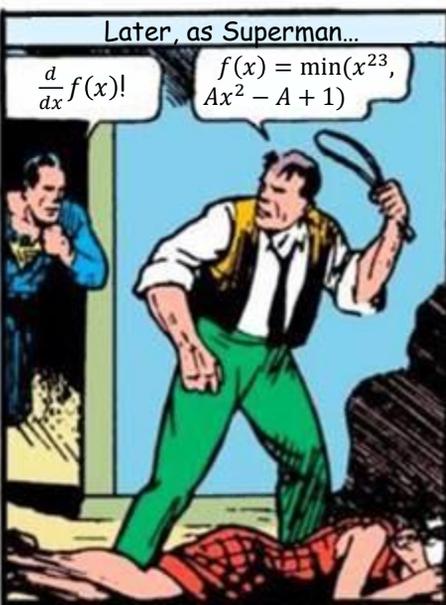
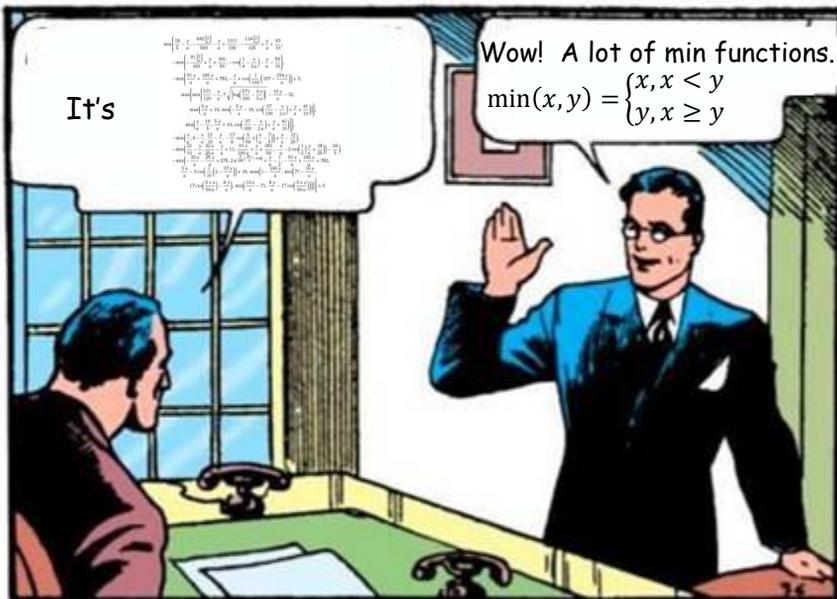
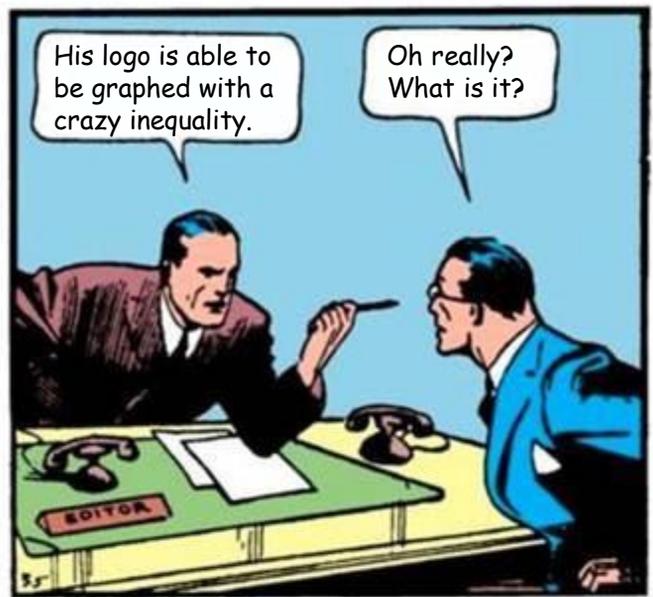
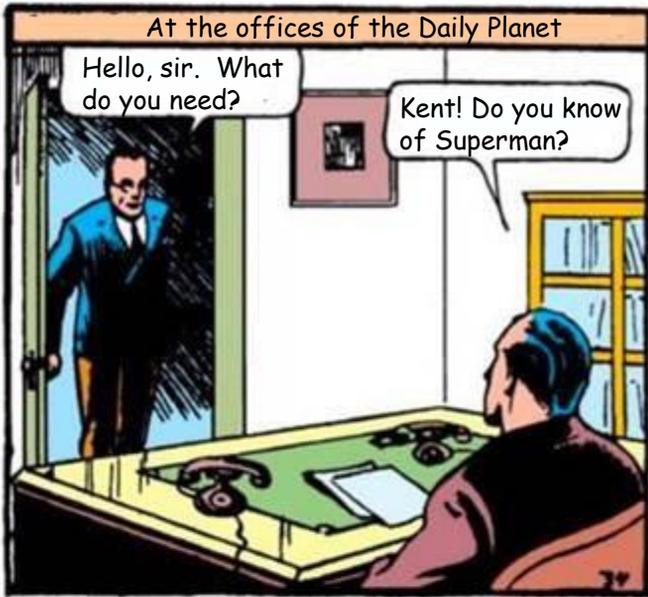


You already know the function. Now I'll say the line is tangent at  $x = 1$



But others heard too, and now they all knew the tangent line!

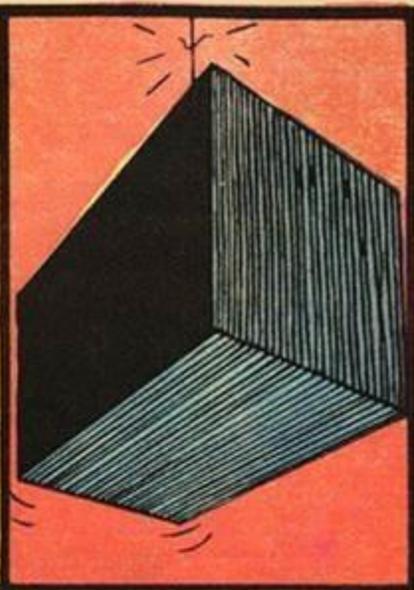
# Question 2



# Question 3

In the land of functions, where each function is represented by a black box, the Wizard reigns supreme.

Billy has been summoned by the Wizard. But why?



I have summoned you, Billy, to unlock the secrets of the land of functions. I know  $H(a) = a^5$ ,  $Z(a) = 7a^4 - 3$ , and  $M(a) = 1/a^2$ . I am interested in integrating the product of  $H(a)$  and  $Z(a)$  with respect to  $M(a)$ .

Do you know what that is?

$\int H(a)Z(a)dM$   
?



You have discovered the secret power of the functions. Now for your full potential, you will need to solve the integral.

I can do that!

**Question 4**

Motivated by the tragic loss of his parents, Bruce Wayne gets to work...



... the most powerful equation I can!



The equation came to him!

$$\left(\frac{5}{2}\right)^2 \sqrt{\frac{|x|-2}{|x|-3}} + \left(\frac{5}{2}\right)^2 \sqrt{\frac{|x+2|}{|x+3|} - 1}$$

$$\left(\frac{5}{2}\right)^2 - \frac{(2\sqrt{33}-2)^2}{112} x^2 - 3 + \sqrt{4 - (|x|-2) - (|x|-9)}$$

$$\left(\frac{5}{2}\right)^2 \sqrt{\frac{(|x|-1)(|x|-7)}{(x-1)(x-7)}} - 8|x|-9 \left(5|x+7\sqrt{\frac{(|x|-7)(|x|-5)}{(7-|x|)(|x|-5)}} - 9\right)$$

$$\left(\frac{220}{7}\sqrt{\frac{(|x|-2)(|x|-9)}{(5-2)(5+2)}} - 9\right)$$

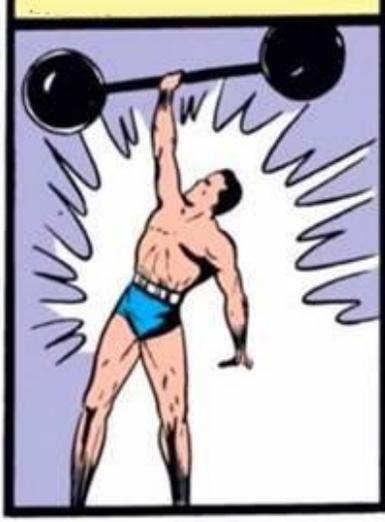
$$\left(\frac{6\sqrt{10}}{7} + (1.5-5i)\sqrt{\frac{|x|-1}{|x|-1}} - \frac{6\sqrt{10}}{14}\sqrt{4 - (|x|-1)^2 - 9}\right) = 0$$



To use it, Wayne needs to become the paragon of intellect...



And the model of physical strength!



The only piece left is to find the area of the region bounded by  $y = \sqrt{1 - (||x| - 2| - 1)^2}$  and the x-axis.



Can you help out Bruce Wayne?



He can become the night!



# Question 5

The Human Torch approaches



He is, of course, on fire.



But what is normal is the line normal to  $y = 20e^{2x}$  ...



... at  $x = \ln 3$



I shall melt this



Wow that really is melting quickly!



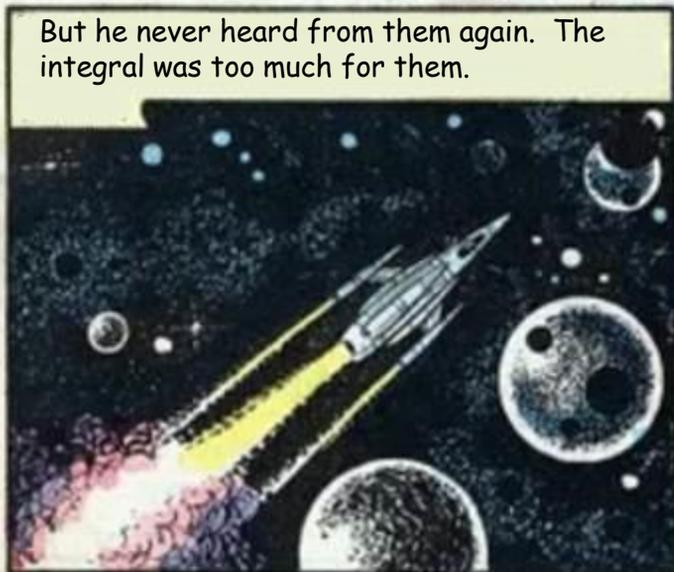
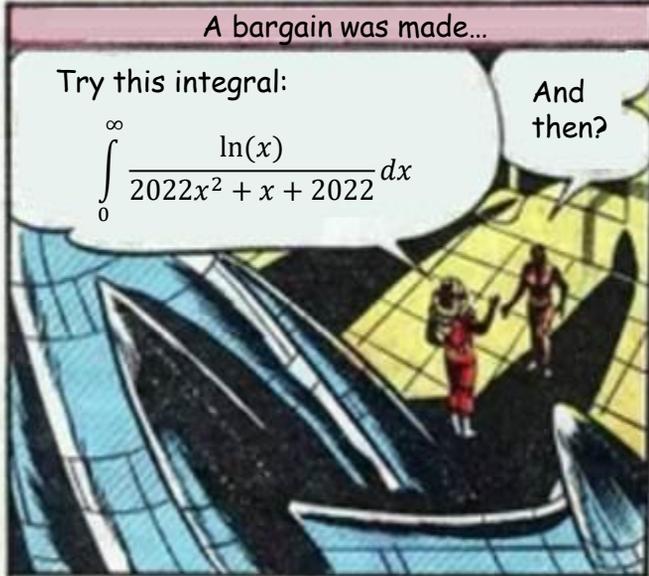
Find the slope of this line!



# THE JUSTICE LEAGUE PLAYS A GAME!

Each of the eight members rolls a fair 10-sided die, and they win if they roll a 10 (10 appears on only one face). The Flash has been to the future and he knows he wins. But, he does not know when he wins. If the Flash is fourth to go, what is the expected number of times he rolls until he wins?

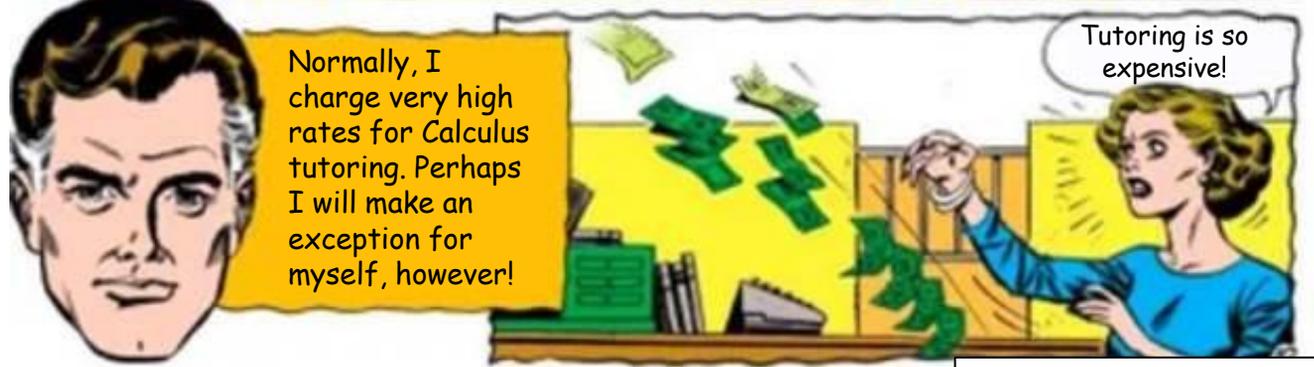
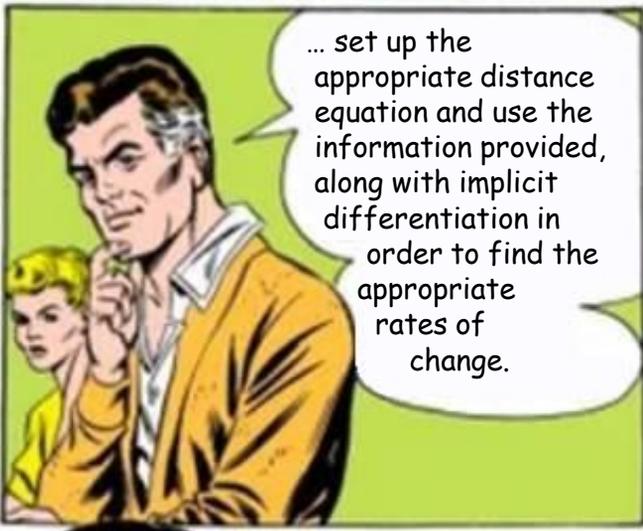
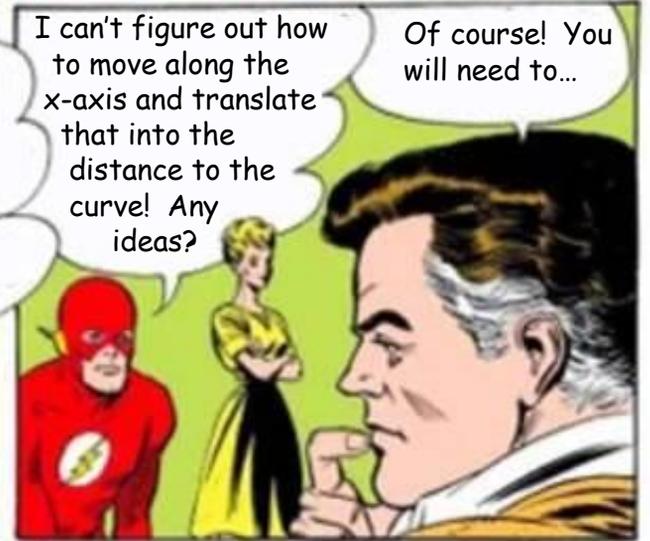
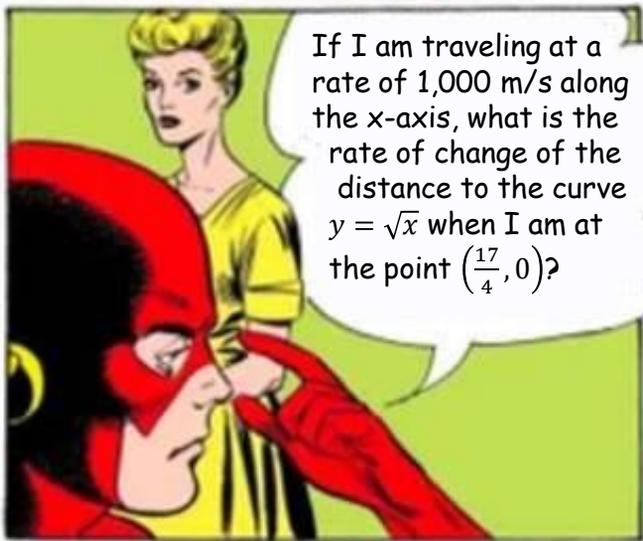
# Question 7



Question 8



# Question 9



# Question 10

Captain America is being defrosted after found frozen in the artic...

This is taking forever!

It's been 3 hours!



During that time, Cap had only warmed 10° C

Ugh



At what temperature... ..did he start? -20° C.



It's Newtonian!  
 $\frac{dT}{dt} = k(T - T_0)$

Cool!



What is the temperature in here?

Really hot, 40° C.



Then when will Cap reach 37° C?



# Question 11

$$\int_0^{\infty} \frac{\left(1 + \frac{1}{x}\right)^{2022x} - \left(1 + \frac{2022}{x}\right)^x}{x} dx$$

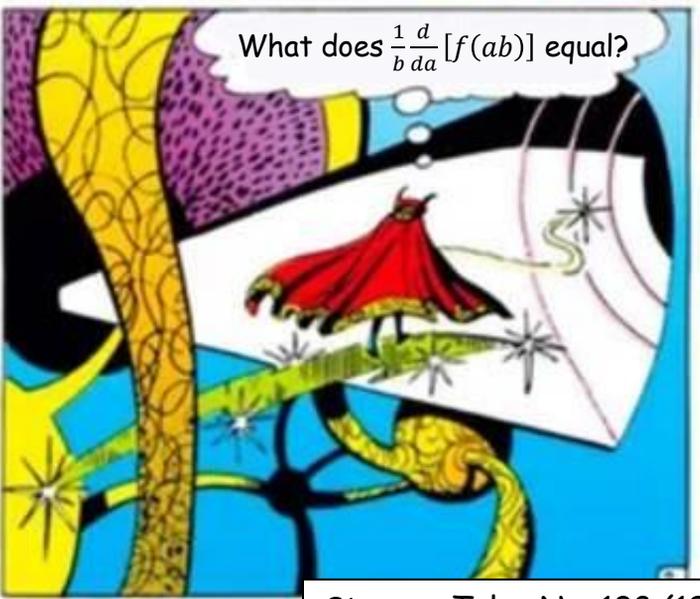
I need you to solve the integral in the yellow box above!



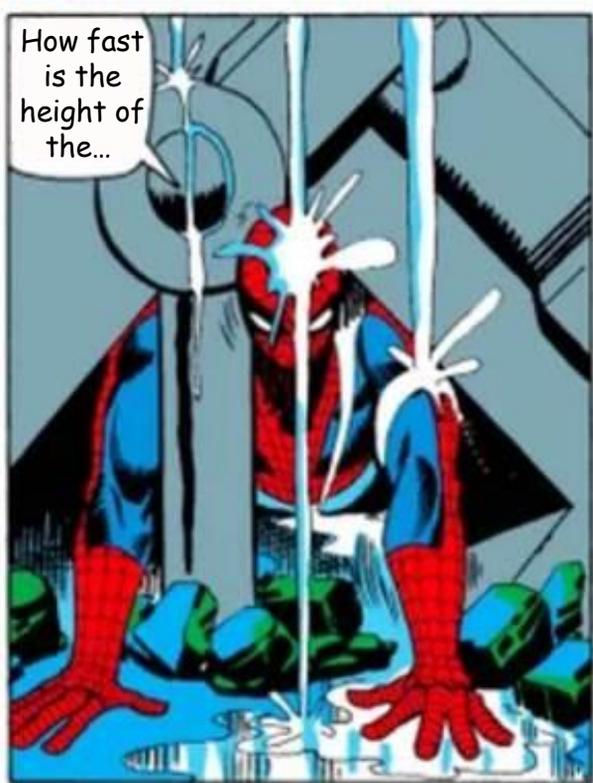
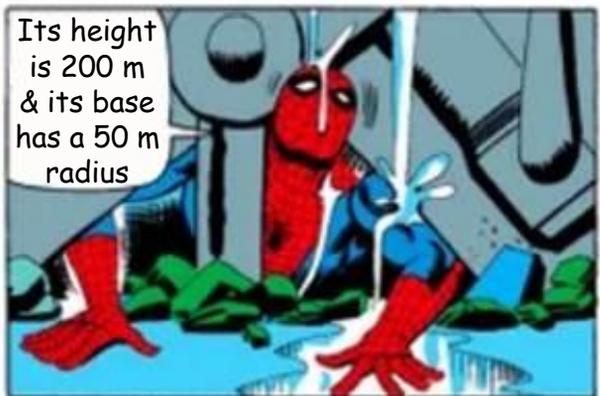
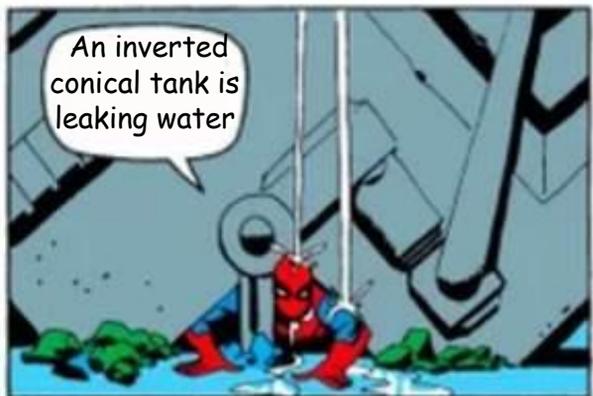
Consider a more general form for the numerator.



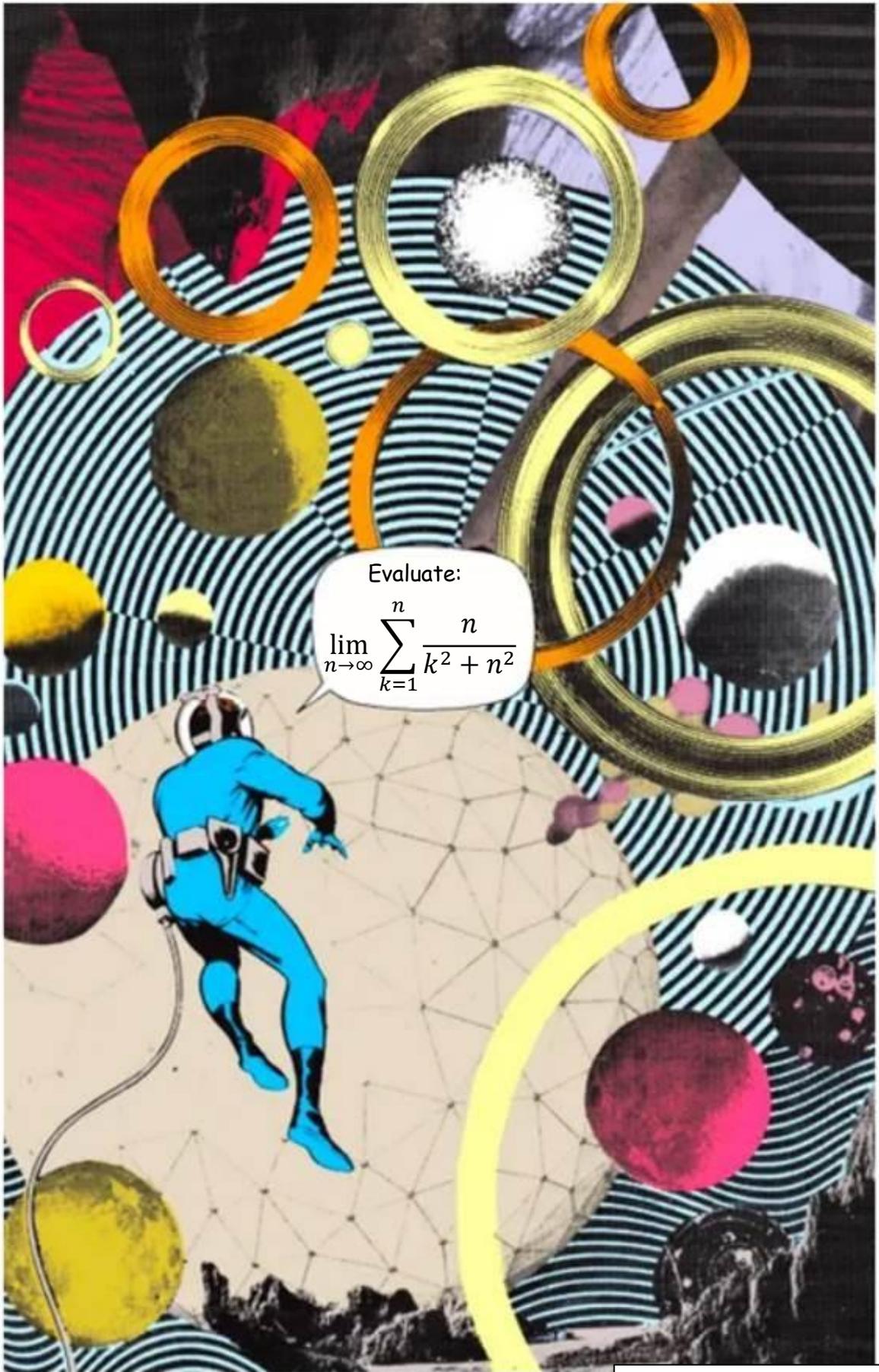
What does  $\frac{1}{b} \frac{d}{da} [f(ab)]$  equal?



Question 12



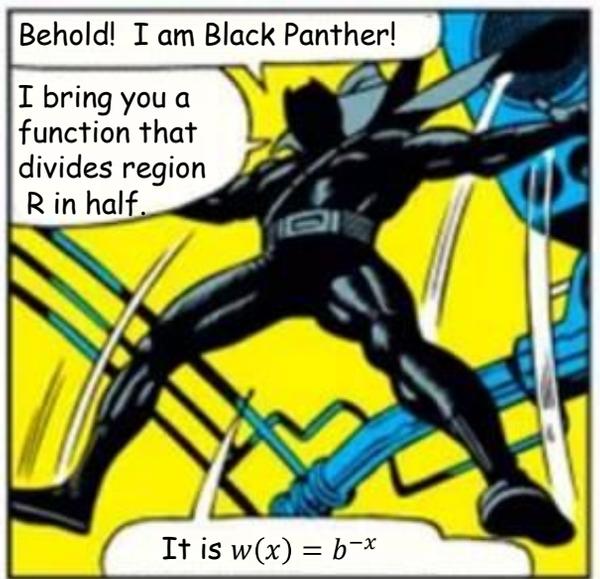
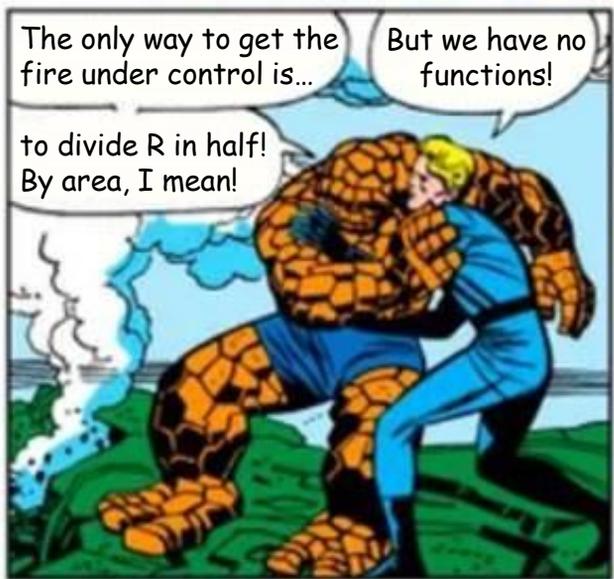
Question 13



Evaluate:

$$\lim_{n \rightarrow \infty} \sum_{k=1}^n \frac{n}{k^2 + n^2}$$

# Question 14



Question 15



I'm giving up because I can't solve...

$$\int_0^\infty \frac{x dx}{e^x - 1}$$

I know it has something to do with series...

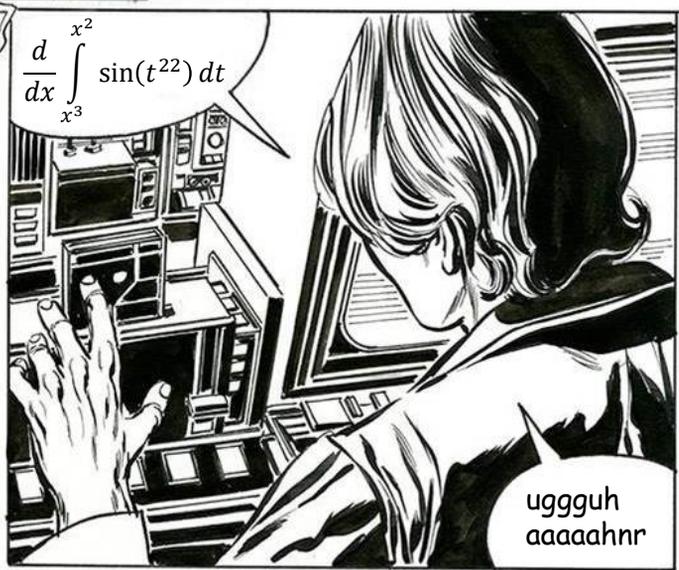
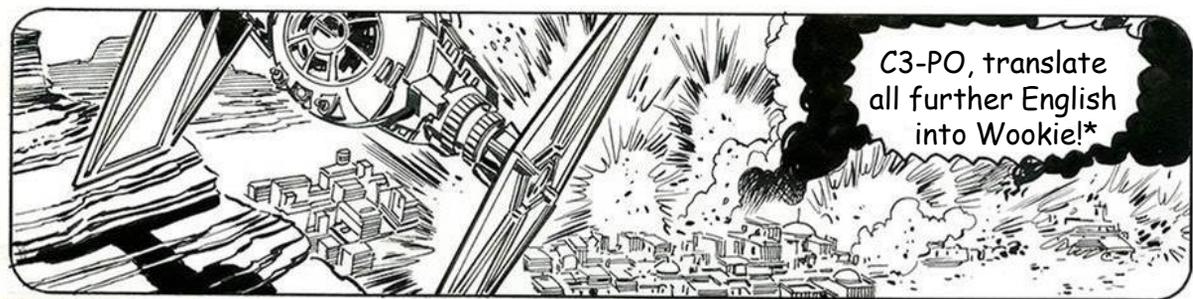
Question 16



Not even with the Mystical Arts can Wanda invert  
 $f(x) = 12x^5 - 3x^3 + 5x^2 + 8$

But she does not need to.  
She just need to know...

$$\left. \frac{d}{dx} [f^{-1}(x)] \right|_{x=22}$$



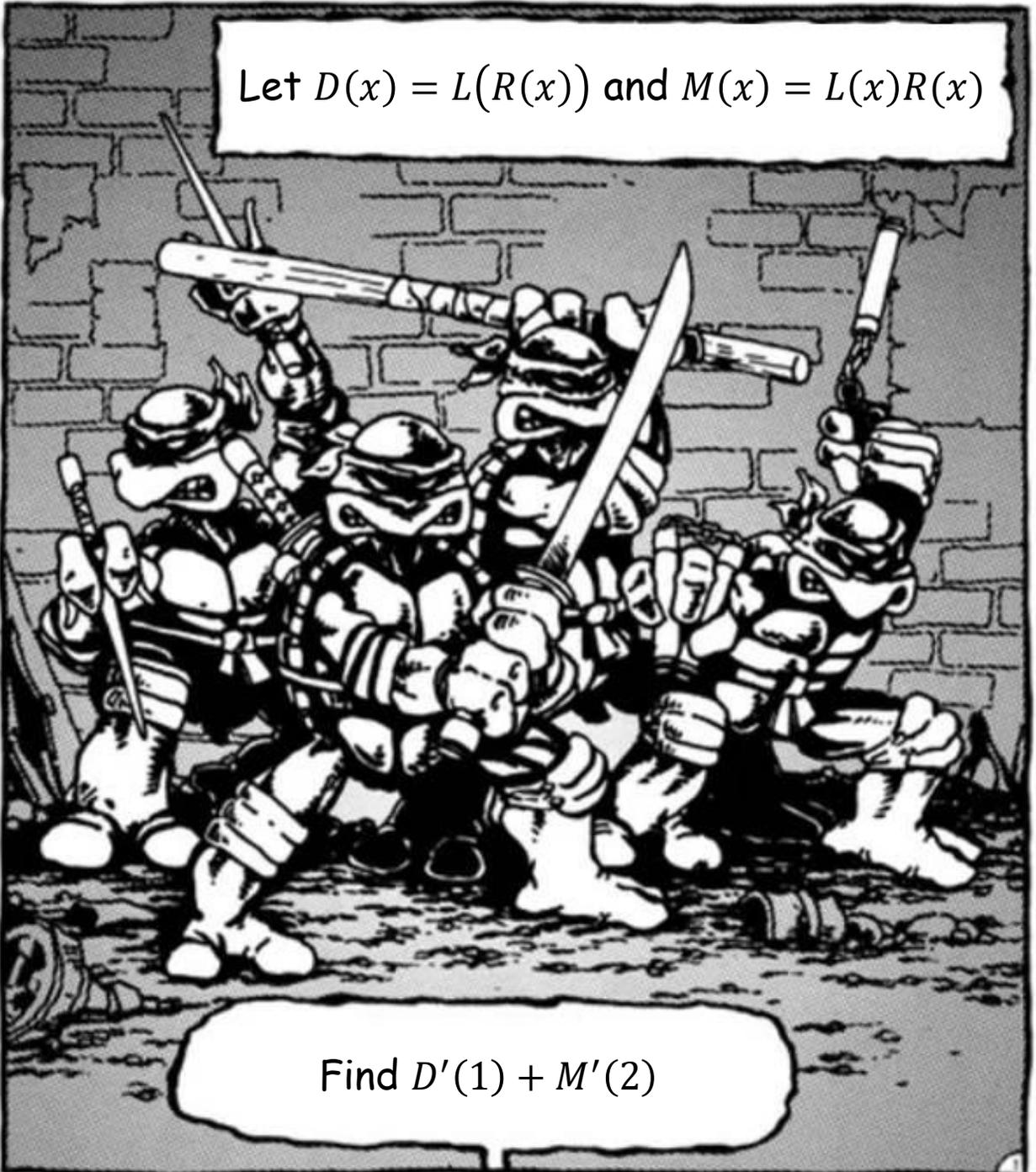
\*<https://www.wookietranslator.com/>

Question 18



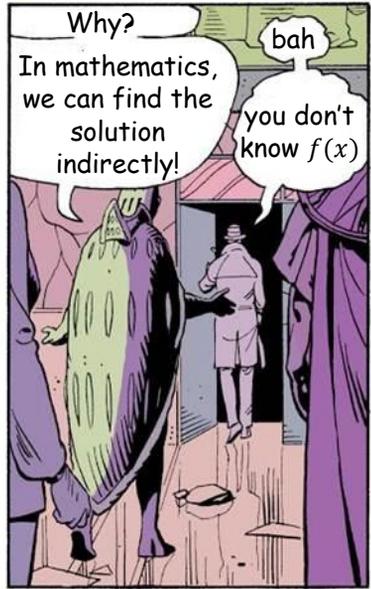
$x =$	1	2	3
$L(x) =$	-2	1	1
$L'(x) =$	9	-1	5
$R(x) =$	3	2	7
$R'(x) =$	4	6	0

Let  $D(x) = L(R(x))$  and  $M(x) = L(x)R(x)$



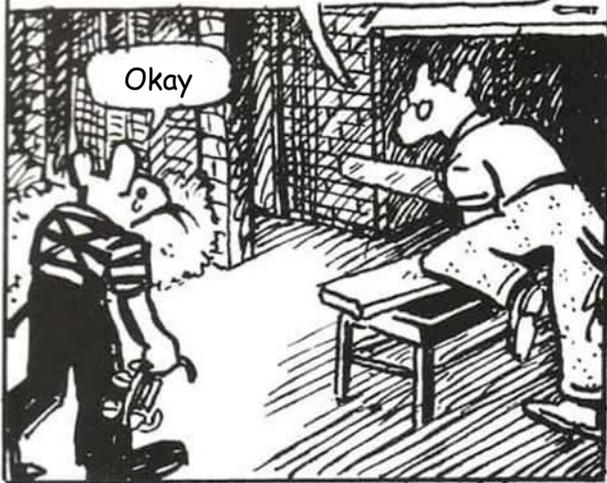
Find  $D'(1) + M'(2)$

# Question 19



# Question 20

A mouse is climbing up a rope tied to the top of a tree 45 meters tall.



The end of the rope is attached to the mouse's tail such that the weight of rope the mouse has already...

That doesn't seem fun

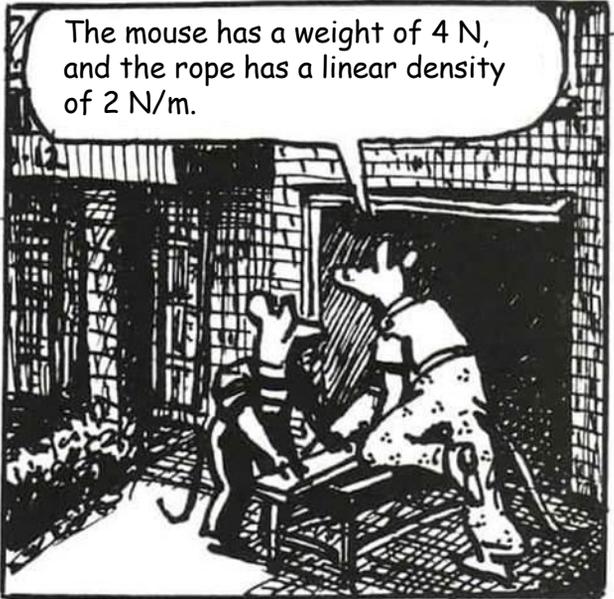


It was not.

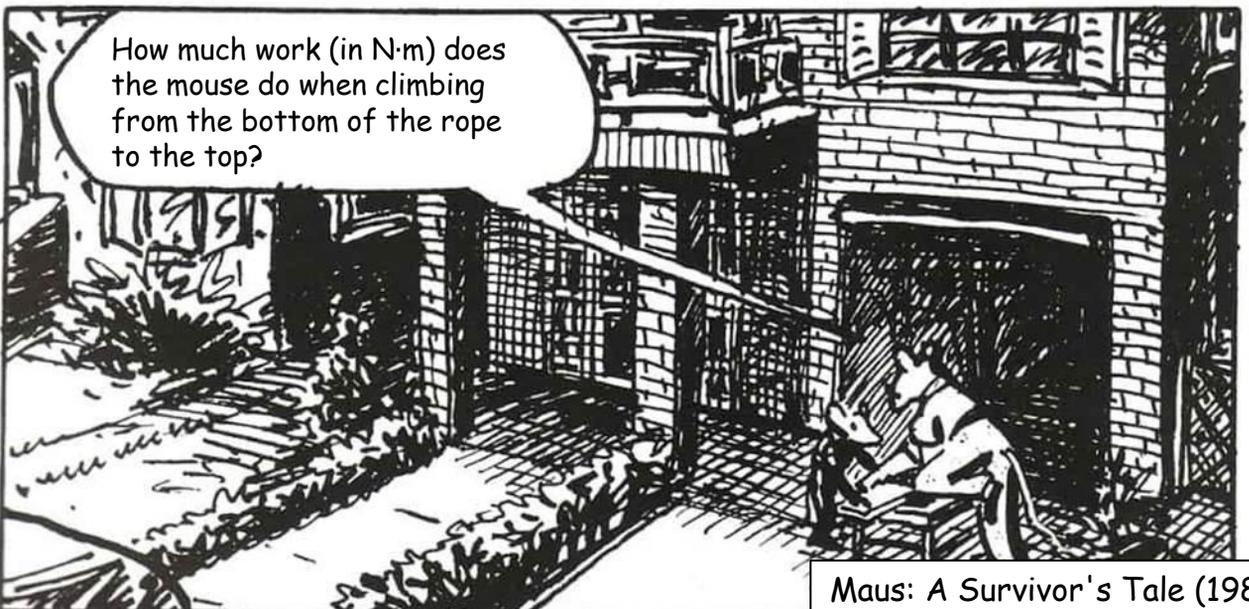
climbed is entirely born by the mouse.



The mouse has a weight of 4 N, and the rope has a linear density of 2 N/m.



How much work (in N·m) does the mouse do when climbing from the bottom of the rope to the top?



# Question 21



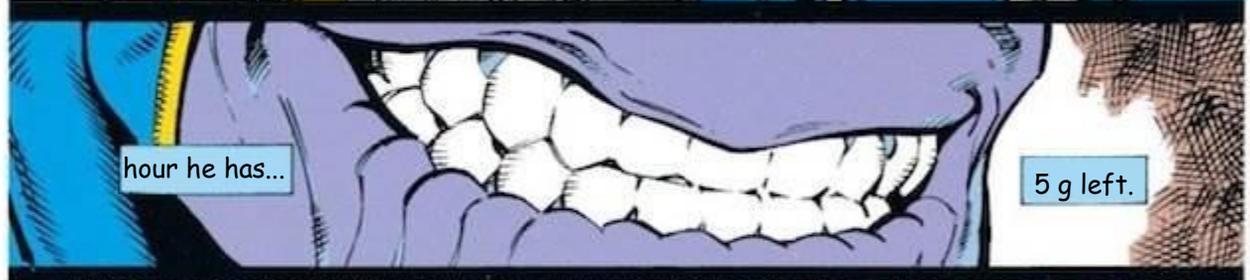
Thanos...

Do this

Question!



starts with 22g of Thorium. In one...



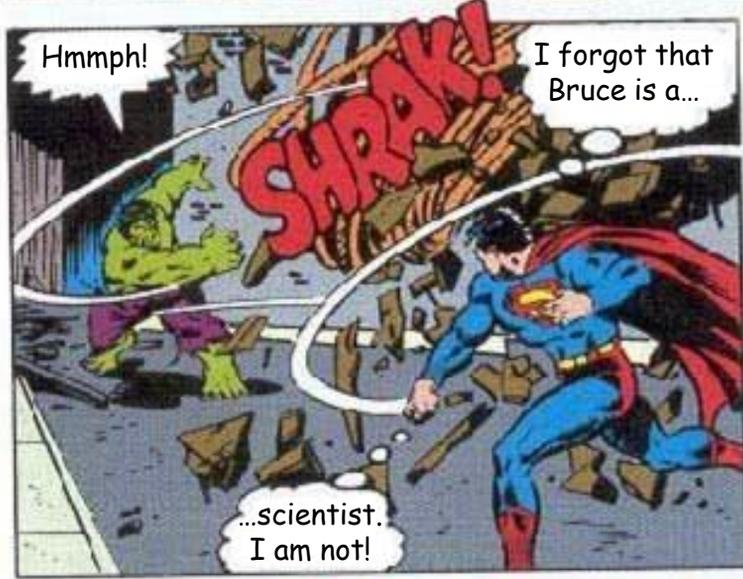
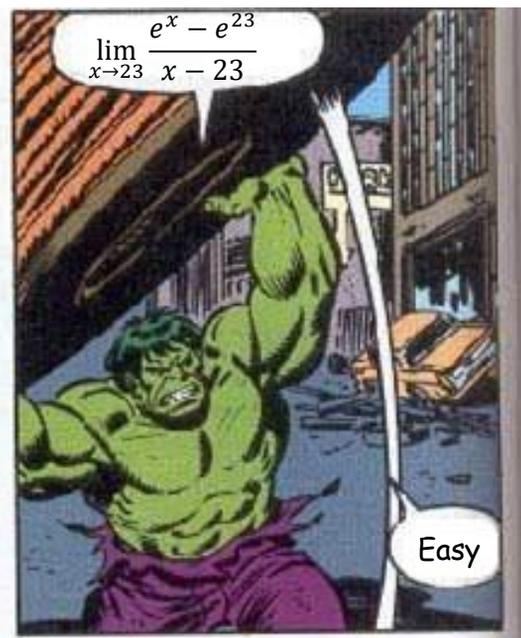
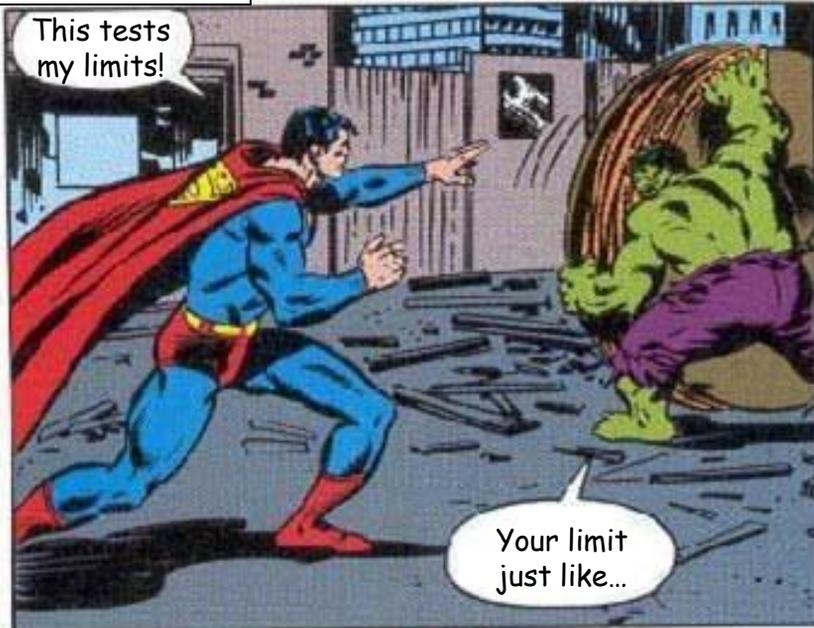
hour he has...

5 g left.



What is its half-life?

# Question 22



The Incredible Hulk vs. Superman (1999)



I bring a challenge!



Evaluate:

$$\frac{d^{2022}}{dx^{2022}} [x^4 e^{x^2}] \Big|_{x=0}$$

How About That?

Find  $\frac{dy}{dx}$  at the point (3, 1) if

$$y^4 x^3 + x^2 - 14y = 22$$

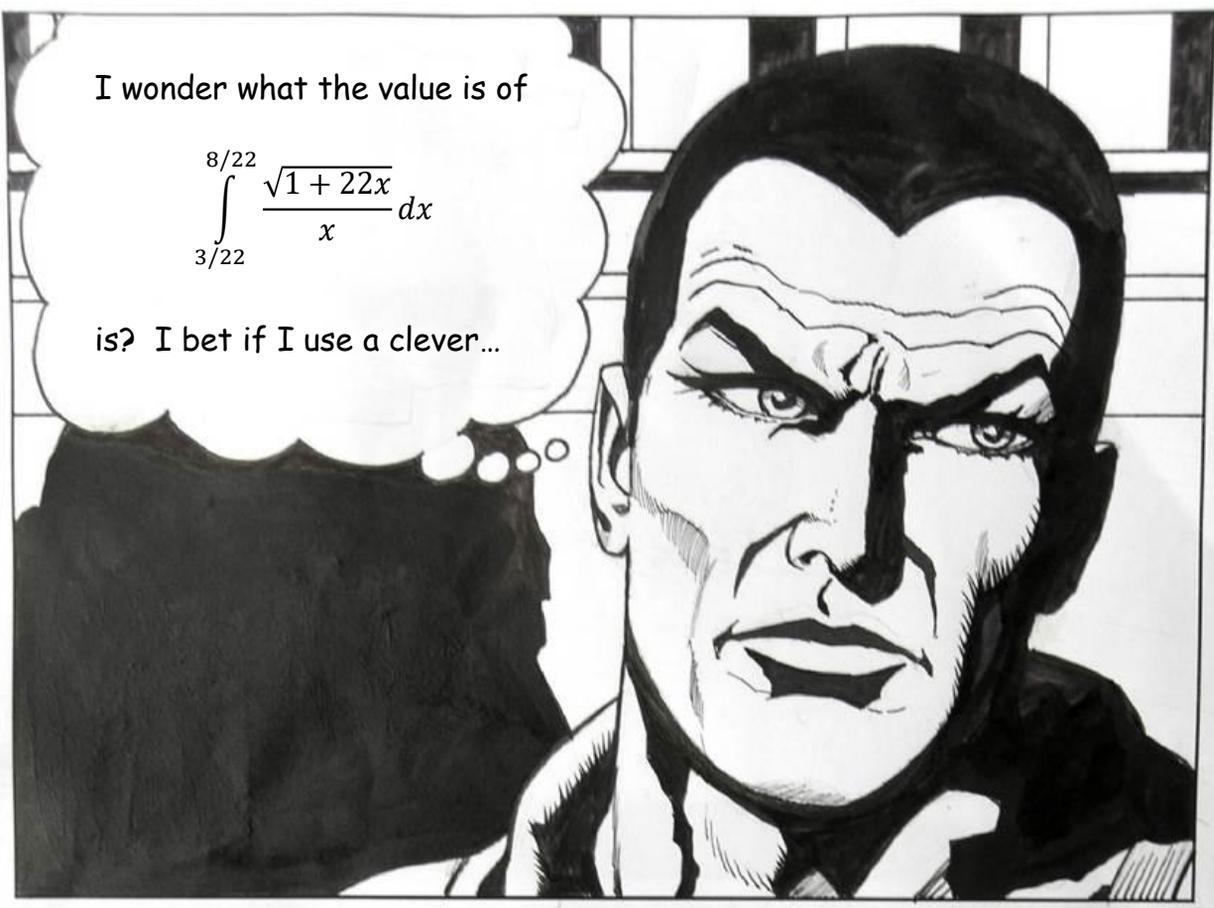




$$\frac{d}{d\left(\frac{d}{d\left(\frac{d}{d(\cdot)}[x^{2022}]\right)}[x^{2022}]\right)}[x^{2022}]$$

Such is the boundless depths of the multiverse, which allows me, Thor, to be a frog: Throg!

# Question 26



# Question 27

Ms. Marvel's hand grows!

Treat it as a sphere, growing...

...3 cm<sup>3</sup>/s...

When r=7

How fast is the radius r changing?







<SNIFF>

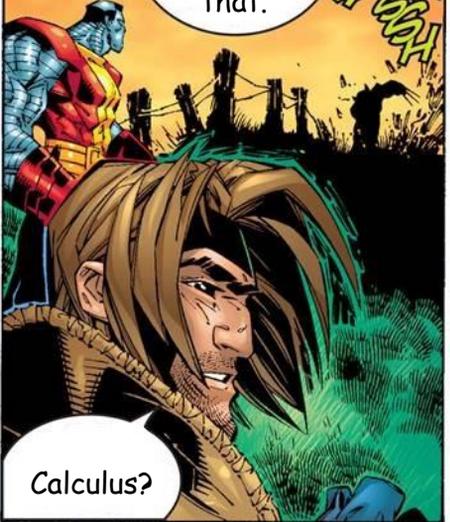
How?

It smells like  $\sqrt{22}$

We need to approximate that using differentials

25 is the closest perfect square. Use that.

*SWASH SWASH SWASH*



Calculus?



I do!

Uh-oh Fire!

Yes, of course.

Don't you know how?



My math is for cards!

# Question 30

Find the number of absolutely convergent series minus the number of conditionally convergent series.

$$\sum_{n=1}^{\infty} \frac{(-1)^n n^2}{n^2 + 2022}$$

What's a neat series?

$$\sum_{n=1}^{\infty} \frac{\cos(n)}{n}$$

$$\sum_{n=1}^{\infty} \frac{(-22)^n}{n!}$$

Exp-citing!

$$\sum_{n=1}^{\infty} \frac{n!}{n^n}$$

Hint: What's the purity of that silver?

$$\sum_{n=1}^{\infty} 2021^{-n - (-1)^n}$$

Ratio won't work!

$$\sum_{n=1}^{\infty} \left(\frac{1}{9}\right)^n \frac{(3n)!}{(n!)^3}$$

$$\sum_{n=1}^{\infty} \frac{1}{n^{\tan(\theta)}}$$

Given this:

$$\sum_{n=1}^{\infty} \frac{(-1)^n n^{2022}}{2022^n}$$

Nice use of year

$$\sum_{n=1}^{2023} \frac{1}{n - 1000}$$

$$\sum_{n=2}^{\infty} \frac{(-1)^n}{n \ln(n)}$$

$$\sum_{n=1}^{\infty} \frac{2022^n}{n} (-1)^n$$

There is no series. Only Ant.

A stylized comic book speech bubble with a thick black outline and a light orange interior. The bubble is filled with a halftone dot pattern. The text "THE END." is written in a bold, pink, italicized font with a thick black outline. The background of the entire image is a light blue field with a regular grid of white circles, creating a halftone effect.

**THE END.**